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TRANSACTIONS AND ORGANIZATION

EIGHTH INTERNATIONAL

CONGRESS
OF APPLIED CHEMISTRY

Washington and New York
September 4 to 13, 1912

VOL. XXVIII

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INTRODUCTION.

At the instance of the representatives of the chemists of the United States, the Congress of the United States by Joint Resolution on March 4, 1909 authorized the President of the United States to invite the Eighth International Congress of Applied Chemistry to meet in the United States. This invitation was extended to the Seventh International Congress of Applied Chemistry in London June second, 1909, by the official delegates to that Congress under instructions from the Secretary of State and the presentation address was made by the Honorable Whitelaw Reid at the request of those delegates; the invitation was enthusiastically and unanimously accepted.

The twelve delegates sent by the Government of the United States to the Seventh Congress of Applied Chemistry were appointed by that Congress as the members of the organizing committee for the Eighth Congress, with power to add to their number.

The President of the United States showed his deep interest in the object and purposes of the Eighth International Congress of Applied Chemistry by consenting not only to act as its Patron but also to preside at the Inaugural Meeting of the Congress.

The time and places of meeting were determined upon after having obtained the views thereon from 44 societies residing outside the United States; the substantially unanimous choice of these societies was early September as to time and Washington and New York as the places of meeting. Washington and New York were accordingly selected and the time from September 4 to September 13 was also selected in accordance with the wishes of these 44 societies.

The following pages contain the record of the work of the Eighth Congress in its various formal gatherings and sessions, the excursions and their itineraries together with a complete list of all the members of the various committees, the Donors to the General Fund and the membership of this Congress.

CONSTITUTION AND BY-LAWS

OF THE

EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

1. The object of the Eighth International Congress of Applied Chemistry is the advancement of all applications of chemical science to practical life.

2. Any person having an interest in the object of this Congress is eligible to membership.

3. Applications for membership shall contain the applicant's declaration of desire to become a member; the applicant's name, title, post-office address and business or occupation shall be accurately set forth, and each application shall be accompanied by the membership fee, which is $5.00.

Application for and acceptance of membership in the Congress is an agreement to accept, observe and abide by the By-Laws of this Congress. The membership ticket will entitle each member to the Congress badge and to participation in all the sessions and other functions of the Congress proper, to one copy of the daily journal of the Congress and to one copy of all the printed matter of the Congress, inclusive of the final Report of the Congress.

A membership card shall be accepted as sufficient identification during the Congress.

4. Tickets for ladies accompanying members can be obtained for $3.00 each, and will entitle them to all the privileges of membership except active participation in the scientific and business sessions and receipt of the Proceedings of the Congress. Bearers of these tickets will be welcome at all social functions.

5. Members attending the Congress should register at the Central Registration Bureau as soon as possible after arrival in New York, and should indicate the Sections or Subsections in whose deliberations they propose to take part.

Each member has the right to vote upon all nominations and resolutions at the general sessions of the Congress, but he is entitled to participation in the debates and conferences of only those Sections or Subsections for which he has registered as above provided.

6. The number of the general sessions of the Congress, as well as the time and place of holding them and the order of business for each, shall be determined by the Executive Committee of the Congress and be announced by them in the daily journal not less than twenty-four hours preceding such general session.

The official languages of the Congress are English, German, French, and Italian.

7. There shall be the following committees:

1. Executive Committee,
2. Finance Committee,
3. Committee on Sectional Procedure,
4. Sectional Committees,
5. Committee on Papers and Publications,

and the Executive Committee shall have the power to appoint such additional committees as may be necessary for the orderly, proper and expeditious conduct of the business of the Congress.

(*a*) The Executive Committee shall have immediate control of, and responsibility for, the carrying out of all business of the Congress. The President of the Congress shall be Chairman of the Executive Committee and with the Honorary President, shall decide and determine its size and personnel.

(*b*) The Finance Committee shall have charge of the collection and disbursement of all funds, and no bills shall be paid without the approval of the President of the Congress and the Chairman of the Committee incurring the outlay, or their duly appointed representatives. No indebtedness shall be incurred without the approval of the Executive Committee having first been obtained.

The Treasurer shall be Chairman of the Finance Committee, and with the Honorary President and the President shall determine the size and personnel of the Finance Committee.

(*c*) The Committee on Sectional Procedure shall decide the order of business and mode of procedure at all meetings of the

Sections and Subsections of the Congress. Its decisions shall be final. This Committee shall consist of all the Presidents of Sections and Subsections, who shall elect their Chairman, and any other necessary officer or officers from among their number.

(*d*) Each Sectional Committee shall have charge of all matters pertaining to the business of its Section or Subsection, and shall provide or procure all the papers for all the meetings of that Section or Subsection. The Sectional Executive Committee shall pass upon the fitness for presentation of all papers offered and also upon the order of business at each session; its decisions shall be final within the Committee.

The Sectional Committee shall consist of a President and a Vice-President, who shall be elected by the Organizing Committee; they shall select a Secretary and other members of their Committee, subject to the approval of the Executive Committee.

The President and Vice-President of every Sectional Committee shall each select one member, who, with themselves and the Secretary of the Section, shall constitute the Sectional Executive Committee.

The President and Vice-President of each Section or Subsection shall be responsible for the conduct of each stated meeting of their Section or Subsection.

The President of a Section or Subsection, or, in his absence, the Vice-President, shall have power to designate Presidents of Honor for each session.

The Secretary of each Section or Subsection shall be responsible for the correct reporting of the transactions of each session of his Section or Subsection.

(*e*) The Committee on Papers and Publications shall receive from the Sectional Committees such papers as they recommend for publication and shall decide whether the same shall appear *in extenso* or in abbreviated form in the printed Report of the Congress. It shall also decide any appeal by the author from the decision of the Sectional Committee on the question of publication, and its action shall be final. This Committee shall be appointed by the Executive Committee, but, as far as practicable, no member of the Executive Committee of a Section or Subsection shall be appointed thereon.

8. The minutes of each meeting, general or sectional, shall contain:

(*a*) The number of the session, the date, time and place thereof, the name of the presiding officer and of the President or Presidents of Honor; also the number of persons in attendance.

(*b*) A list of all papers read and all reports given at the session in the order in which they were actually read, the name and address of those reading the papers, and also the names of all members participating in the discussion, together with their remarks or the substance of their remarks.

(*c*) Resolutions and conclusions when adopted.

9. Resolutions and conclusions of Sections or Subsections shall be adopted by a majority vote of those attending the last stated meeting of that Section or Subsection and at no other meeting. A proposed resolution or conclusion must be presented in writing to the Secretary of the Congress at least forty-eight hours prior to such last stated meeting, and it shall be his duty to print the same in the daily bulletins, provided, however, that pertinent written amendments to the printed form which do not affect the substance of the proposed resolution may be adopted at such last meeting.

No resolution in which legislation is recommended to any particular Government shall be passed by the Congress or by any Section or Subsection thereof.

10. (*a*) The Executive Committee of the Congress is to decide and determine upon what addresses shall be given at the general sessions of the Congress, what motions and questions shall be put to the Congress in general meeting assembled, except as hereinafter provided; its decisions shall be final.

(*b*) Special addresses before sections or joint meetings of two or more sections, and the motions to be put before such joint meetings, shall be submitted to the Executive Committees of the Sections holding such joint meeting, and their decisions shall be final.

11. The Executive Committee shall have power to decide all matters not touched upon in these provisions, and shall continue in existence until the work of the Eighth Congress is finished,

and shall, prior to its disbandment, transmit all current business to the Organizing Committee of the Ninth Congress.

The time and place of the holding of the Ninth Congress and its Organizing Committee, which shall have power to add to its number, shall be determined at the last general session of the Congress.

12. A quorum in all sessions of the Congress or its Committees of any kind shall be constituted by those who attend a stated meeting, and the majority vote of such quorum is conclusive, final and binding.

The Honorary President and the President of the Ninth Congress shall be nominated by the International Commission of the Congresses of Applied Chemistry to the Eighth Congress at its last general meeting, for election. The President of the Ninth Congress is to be Chairman of the Organizing Committee of that Congress.

RULES ON PAPERS, THEIR PRESENTATION, DISCUSSION AND PUBLICATION

1. Papers or other like contributions should be *original and not elsewhere read or published;* however, prior publication of Governmental researches, which publication is made in accordance with the law of such country, shall be exempt from the above restriction as to publication.

2. All papers or like contributions should be as *concise* as possible and must contain the name and post-office address of the respective authors; further, what number, if any, of reprints is desired. (See Rules 8 and 10.)

3. All papers should be *in duplicate* and legibly written, preferably typewritten; formulæ should be carefully inserted by hand as simply as possible.

4. Each sheet should be as nearly 8 x 12 inches as convenient and should be written on one side only, and *not* on both sides.

5. Each paper should be accompanied by an abstract thereof *in duplicate;* formulæ should be carefully inserted by hand, as simply as possible.

6. All references to other work should state carefully the sources of the citation, giving the exact reference to the original publication.

7. Illustrations, curves and the like should be on separate smooth white sheets and drawn and lettered with Indian ink clearly enough to bear a linear reduction to one-half or two-thirds and when so reduced should not exceed the page size of the "Report," which will be about 4¼ by 7 inches.

8. Authors of papers which are to be illustrated by lantern slides are urgently requested to state on their paper the size of slide used so that suitable arrangements may be made. Failure to observe this may result in disappointment and delay. (See Rule 2.)

9. The Congress obligates itself to have its final Report and Proceedings, including subject and authors' index, completed and ready for distribution on or before December 31, 1912; in case those Reports and Proceedings be not ready for distribution by that date, authors of all papers received and accepted *after* June 30, 1912, may then publish in any journal or publication that they may elect. (*Note:* This refers only to the Report and Proceedings bound in paper; members desiring cloth bound sets can obtain them at an advanced charge over the $5.00 membership fee; such advanced charge will be announced later, but will probably be $2.50; delivery of these cloth bound sets will be about 90 days later than of the paper bound sets.)

Authors of papers received *before* the close of June 30, 1912, may publish those papers in any publication they may elect *after* the paper is read or *after* the Congress has adjourned. (See Rule 12.)

10. Authors of papers accepted and printed in full or in abstract will receive free of cost and all delivery charges, not to exceed fifty (50) reprints of each paper or abstract; additional copies of reprints can be had upon payment of the prices for such copies, which prices will be announced later. The Congress cannot undertake to furnish reprints of papers if the order for such reprints is not attached to the paper or abstract when received by the American Committee. (See Rule 2.)

11. Papers and their abstracts, *both in duplicate,* must be in

the hands of the American Committee not later than June 30, 1912. All papers received *prior* to that time and accepted will be printed in their respective Sectional Volumes and distributed to such of the attending members of the Congress as may desire them, at or before the opening of the Congress. Papers received *after* that time, if accepted, will be printed, but may appear in an appendix which may or may not be ready by the opening of the Congress; the Congress cannot then undertake to print them along with the papers of those sections to which they may be assigned and which were received prior to June 30, 1912.

12. No paper offered to and accepted by this Congress can be at any time published elsewhere without giving credit to this Congress for such article or publication. However, Governmental publication of papers contributed to the Congress is exempt from the above requirement as to giving credit to this Congress.

13. All authors, as a matter of course, agree not to publish their accepted papers in any other publication except as herein provided, and, further, they agree to abide by any final decision of the Congress with respect to such paper or papers, their presentation, discussion or printing.

14. Rejections by Sectional Committees will not be final; their decisions will be reviewed by the Committee on Papers and Publications, but rejection by that Committee will be final.

15. Authors of finally rejected contributions will be notified in writing of such rejection immediately after it has been made, and, as far as the Congress is concerned, such final rejection is strictly secret and confidential. Rejected manuscripts are to be returned to their authors. (See Rule 16.)

16. The Congress will not publish a list of rejected papers nor state what papers have been rejected; directly after the closing of the Congress all records relating to rejected papers and like contributions will be destroyed; any and all proceedings as to rejected papers or like contributions, so far as the Congress is concerned, will be strictly secret and confidential.

17. Any paper which is of a pronounced polemical, advertising or personal character may be thereby disqualified and for that

reason alone rejected, regardless of whatever merit the paper may otherwise possess.

18. The Congress reserves the right to reject any paper or other contribution that may be offered to it.

19. The Congress reserves the right to print the full paper only, or the abstract only, or the title only, in each case with the author's name and post-office address.

20. Authors are requested to state on the papers themselves their preferences for the sections in which they wish them to be read; the Congress will respect that request wherever practicable, but reserves the right to assign the paper to any other section that may be deemed more appropriate, and such disposition is final.

21. Authors will *not* receive printer's proofs of their papers or abstracts; nor will their papers or abstracts be revised after receipt by the American Committees; printing will be accurate to copy.

22. The time consumed in reading or presenting the substance of any paper by an author or his representative at a meeting of a Section must not exceed ten (10) minutes, except by special permission of the Sectional Executive Committee.

23. In the absence of an author or his representative the paper will be read by title only, and if there be any discussion it must be based upon the paper as printed because neither the paper itself nor its abstract will be read; exceptions to this rule can be made only under regulations that may be adopted by each Sectional Executive Committee.

24. Discussions of a pronounced polemical, advertising or personal character may be ruled out by the Chair on that ground alone and not permitted to appear in the printed record; the ruling of the Chair in such matters is final and is not subject to revision or appeal.

25. Participants in discussions will be given an opportunity of editing the manuscript reports of their remarks, but printer's proofs will not necessarily be submitted to them, although whereever practicable they will be so supplied.

26. Participants in discussions must speak from the rostrum and *not* from the floor.

THE INAUGURAL MEETING

AT WASHINGTON.

The Eighth International Congress of Applied Chemistry held its Inaugural Meeting in Continental Memorial Hall, Washington, D. C., on September 4, at eleven o'clock, under the Presidency of Dr. William H. Nichols.

The stage was occupied by President Nichols with Dr. E. W. Morley, Honorary President, on his right, and Prof. L. Lindet on his left, and on either side of these the Delegates designated to respond to the addresses of welcome. There were also present on the stage the Delegates representing Foreign Governments, the members present on the Executive Committee and the Presidents of Sections of the Congress.

The Rev. Bernard G. Braskamp of the Church of the Covenant, Washington, delivered the Invocation.

Major Thomas L. Rhoads, U.S.A., A.D.C., the official representative of the United States, waited, in person, upon the President of the Congress and announced that the President of the United States, in spite of a personal injury received at Beverly, Massachusetts, the day before, had come to Washington for the purpose of opening the Congress. He found himself, however, unable to stand and must defer his opening address until the Reception at the White House in the afternoon. This was announced to the Congress by President Nichols, and by his direction the text of the address of President Taft is inserted below as part of the proceedings of this Inaugural Meeting.

THE PRESIDENT OF THE UNITED STATES:

"*Mr. Chairman, and Ladies and Gentlemen of the International Congress of Applied Chemistry.*

"I have much pleasure in welcoming you, on behalf of the Government and people of the United States, to Washington.

I sincerely hope that your stay in this Capital may be an agreeable one.

"Yours is one of those important International Congresses that mark the great progress which has been made in research and application of newly-discovered principles in a most important science and art. If there be any science that goes to the heart of the matter, it is chemistry. Dealing with atoms and molecules and their association, and the manifestations of their action upon each other, chemistry seems at one time the most abstruse of sciences, and then when we see it applied in the great modern factories in the manufacture of those elements which are essential to the success of the industrial arts, we are made to know that the extent of the science from the theoretical to the practical is wider than that of any other.

"I observe that in your various divisions you discuss many different questions not peculiarly chemical. I note a consideration of the question of patents,—what patents ought to include, and what kind of a patent system ought to be adopted by each Government. Patents have played a very great part in the development of the United States, and we have given to patentees a very valuable monopoly for the purpose of discovering by their industries, new methods of accomplishing useful results. Whether we have made this monopoly too great or not is now the subject of consideration by a commission provided for by Congress. There is certainly great room for improvement in the machinery of our Patent Office, and it would be well if more value could inhere in the issuing of a patent as evidence of real property. Now, however, until a patent has been fought through the courts, people do not seem to regard it as of a great deal of monopoly value.

"I may add that one of the great opportunities for reform, in my judgment, is in the shortening of patent litigation and the reducing of its expenditure. I know very little about chemistry, but I know a good deal about patent litigation. I know that the amount of money that has been unnecessarily wasted, and the inequality that has been produced between the rich litigant and the poor litigant, by reason of the unnecessary expense of that litigation, is one of the things that calls for remedy—and immediate remedy. It is not essential that we should make a record of 10,000 printed pages at $50 a day for experts and $100 a day for patent lawyers. I have no objection to experts. I have no objection to patent lawyers, but I think we can have too much of both of them. What ought to happen is that the expert should be called into open court, should there be examined on the principal points of the case, and then dismissed, and not have that interminable system of records, which every judge who has had any experience in respect to patent law must condemn, on the one hand, because of its uselessness, and on the other hand because of its expense. You observe that I am willing to make a diversion in the direction of which I know something. But it is not for me to discuss a subject that is only distantly related to the main purpose of your coming.

"I regret exceedingly that the weather is such as not to permit you to enjoy the beautiful grounds of the White House as fully as you could on a sunny day. I have come a long distance to meet you, in order to emphasize as much as I can the importance which the American Government and the American people attach to your deliberations and the subject-matter of your consideration, and the anxiety and concern they have in promoting every International Congress which makes, as this does, for 'Teamwork' in the world's progress."

President Nichols then opened the Congress with the following Inaugural Address:

"On behalf of the great army of American chemists, more than six thousand in number, and representing all branches of the profession, and in the name of the great industrial organizations depending on their services, and also of the Universities, Colleges and Technical Schools, where many are devoting their lives to instruction, it is my privilege also to extend a hearty welcome to our guests from all the corners of the earth.

"We are gathered together to compare notes and to add to what has been done before, thus contributing to the great structure of the future something of perhaps vital importance to its growth and symmetry. We realize that this is an age of coöperation rather than of destructive competition, and we therefore unite our efforts that the resultant may be worthy of us. We are here to give, that we may receive, and thus pass on to the world something more than our isolated efforts could make possible. The alchemist of the Middle Ages worked alone, seeking the philosopher's stone, or perhaps the elixir of life, vainly hoping to transmute baser things into gold, or indefinitely prolong the joys of youth. We work together, and much has come to pass in the transmutation not of the elements, it is true, but of useless into useful things, and much has been accomplished in the betterment of the whole span of life. It is true we cannot see the goal and cannot even imagine what it will be when discovered in the distant future, but we are trying to do our share of the onward work so that those who succeed us will be better prepared to take their part because of what we have done.

"Coöperation such as ours becomes not only a delight, but a moral quality. To this symposium we of the new world cordially welcome those who from other lands and other experiences come to add their assistance and sympathy.

"To this word of welcome to our guests I am sure you would have me add one of appreciation of our Chairman, President Taft, who has torn himself away from a well earned and needed rest to come here to preside at this opening meeting of our Congress—a worthy successor of the kings and princes who have similarly, honored those which preceded it. While his genial nature leads him to do this freely, we none the less appreciate that the chemists of the world, whether present with us or not, are under obligations to him which they can never repay. I am sure that I speak for you all when I tender to him our united thanks for the honor he has conferred upon us and on the science which we love.

"Since our last Congress, held in London in 1909, no past officials of the congress have died. Sir Henry Roscoe, Honorable President of the Seventh Congress, has met with great affliction in the loss of his dear wife, but with that exception death has not entered into the homes of those who have presided over former congresses. We extend to him today our heartfelt sympathy, added to our regret that advancing age has prevented him from being present with us today. I am sure he is with us in the spirit.

"The President of the Fifth or Berlin Congress, Prof. Otto N. Witt, of Charlottenburg, has also been prevented from attending. I am sure that anyone who has met him, or who has known of his great works, will join me in the expression of deepest regret that one of the most brilliant lights of the chemical world cannot be with us. Those of you who had the good fortune to hear his scholarly address at the Seventh Congress will, to some extent, appreciate what he could have added to this Congress had he been present.

"Prof. Emanuele Paterno, President of the Sixth or Roman Congress, finds himself at the last moment unable to attend. Up to a few days ago I felt sure of his presence, and was therefore all the more disappointed at his change of plans. We shall miss him greatly, although there are worthy representatives of his country here.

"We are very fortunate in having with us Professor Lindet, President of the Second Congress; Sir William Ramsay, President of the Seventh Congress, and Dr. Friedrich Strohmer, of the Vienna Congress. These, with those I have named, are the only living members of the International Commission of Congresses of Applied Chemistry, and we are happy to welcome them and to know that we are to have the benefit of their great wisdom and experience during the conduct of the affairs of this Congress.

"I am pleased to report that a very large proportion of the Original Communications to this Congress has already been printed and bound, twenty-four volumes in all, and will be distributed to members on registration at Columbia University on their return to New York. I think this is worthy of mention, as I believe it is a result which has never been accomplished before, and which could not have been accomplished now but for the magnificent and untiring work of our Secretary, and the coöperation with him of the officers and members of the Sectional Committees and the Committee on Papers and Publications. It is hoped that with these transactions in hand the discussions of the papers will be of great value. Thanks to the effective assistance of Mr. Edison and his staff, arrangements have been made to record these discussions on the phonograph in the official language employed, and this in itself will represent an added novelty in our Congress, and, at the same time, insure an accurate report.

"We are also fortunate in having some of the foremost chemists of Europe as lecturers on subjects of great importance; and, anticipating the public interest which these lectures will arouse, arrangements have been perfected to make them available for large numbers.

"The past fifty years have seen marvelous improvements in all branches of science. This is not the time or place to discuss details, but I feel justified in saying that the science of chemistry during the great evolutionary period, has not been outstripped by any of the others. While its work has been more quiet, and has not been so obvious to the general public, it has been none the less of supreme importance. I believe it is gradually being realized that the world of the future will depend more upon the science of chemistry than upon any other, and may even have to look to it for its continued life. As its mines become more and more exhausted, and its lands more and more depleted of power to grow crops, it must turn to chemistry for instruction as to prevention of wastes and uses of power and materials, which, without ministrations, would be useless.

"With this thought in our minds we welcome with more than ordinary cordiality our foreign guests—some of them from the antipodes. We invite them to aid us in the solution of the great physical problems which confront us as a nation. We have had, and still possess, magnificent natural resources; we have perhaps done with them the best that we could, but we are becoming more and more alive to the fact that the problems are vast and complex. These natural resources must be exploited, but I conceive it to be of much more importance that they be intelligently conserved. The assistance of those who have of necessity had these problems in conservation always before them will be doubly welcomed by us who have been so prodigal in the expenditure of our great wealth.

"The development of our country has been extremely rapid, but the thoughtful ones among us realize that the time is at hand when lavish expenditure must be succeeded by prudent conservation in order that we may not only pass down to posterity a record of wonderful evolution, but insure that we have not robbed our children's children of the materials necessary for their own progress.

"With these ideas we will proceed to our labors at New York with light hearts, believing that great good will come to our country and to the world as a result of those labors, not only in the immediate future, but more particularly in the more distant future which it is our bounden duty to carefully and religiously protect."

Dr. Nichols then introduced Professor Edward W. Morley, Honorary President of the Congress who spoke as follows:

"The Eighth International Congress of Applied Chemistry, assembled according to the invitation of the President of the United States of America, and by the authority of the Congress of the United States, desires to express its gratitude for this invitation, and further, its especial gratitude for, and high appreciation of, the honor done us, Mr. President, by your consent to open the deliberations of this Congress.

"It is my privilege, fellow members of the Congress, to express to you the cordial welcome with which the chemists of the United States receive you to their country. This cordial welcome we gladly offer to visiting chemists from every country of the whole world. Moreover, both the representatives in this country of applied chemistry, and also the lovers and followers of pure chemistry, take a special pleasure in welcoming chemists from the four nations whose languages are the official languages of this Congress. It was among these nations that, something like a century ago, chemistry as we now understand it had its origin. Lavoisier established an anti-phlogistic chemistry, Dalton founded the atomic theory, Liebig furnished organic chemistry with methods, and Avogadro helped us to an insight into molecular weights. During the century since these magnificent beginnings, the progress of chemistry in these four nations has been well worthy of the beginnings.

"At the time of these brilliant beginnings the United States of America were but just become an independent nation. The work of the hour on this continent was to organize the mechanism of civilization in the wilderness which then covered much of our area. Pure chemistry had to wait while roads and bridges were built and the forest was cleared. Our studies and energies had to be expended upon the difficult problems of conducting a popular government—problems which we are optimistic enough to regard as not incapable of solution. The organization of universities by private initiative and at private expense, and the organization of elementary schools at public expense over almost half a continent, diverted able men from research in pure science. The necessities of mine and furnace and factory led men, who might have stood high as investigators, to use their energy and insight in applying chemistry to industry, and adding to the wealth of the country and the comforts of life.

"Accordingly, the chemists of this country are delighted to welcome chemists from the nations who have been our masters and teachers in pure chemistry. The debt which we owe to the chemists of these nations is incapable of repayment. But if any courtesies which we can show you, any provision for the pleasure of your visit which we can make, any solicitude for the success of your deliberations which we can feel, should suggest that such repayment would be to us a privilege and a pleasure, and a great delight, we should but feebly express the warmth of the welcome with which we receive you to the sessions of the Eighth International Congress of Applied Chemistry."

At the close of this address, Dr. Nichols said:

"There is a piece of business, ladies and gentlemen, that we have to perform before proceeding further. I wish to propose that the Vice-Presidents and Presidents of Committees, both Foreign and American, with the members of the joint organizing committees and secretaries, should be elected officers of the Congress, and that the Delegates of Foreign Governments and Universities be elected as Honorary Vice-Presidents.

"I will now put that to vote. Those in favor of this election will kindly signify the same by holding up their hands."

The resolution was adopted unanimously.

Responses to the addresses of welcome were delivered by foreign delegates in accordance with the following program, each address being followed by the appropriate national air rendered by the United States Marine Band.

Prof. Dr. Rudolph Wegscheider, for Austria.
Prof. L. Lindet, for France.
Prof. Dr. von Buchka, for Germany.
Sir William Ramsay, for Great Britain.
Dr. Jokichiro Yemori, for Japan.
Commanditore Giacome Ciamician, for Italy.
Prof. P. I. Walden, for Russia.
Prof. Belisario Diaz-Ossa, for South American Republics.
Prof. Dr. F. P. Treadwell, for Switzerland.
Dr. Samuel Eyde, of Norway, for other countries.

Response of Professor R. Wegscheider:

Im Namen der Oesterreichischen Regierung und der Kongressteilnehmer aus Oesterreich habe ich die Ehre, für die freundliche Begrüssung herzlich zu danken, die uns hier zuteil geworden ist. Wir sind der Einladung des amerikanischen Komitees für den 8. Internationalen Kongress für angewandte Chemie gerne gefolgt, um so lieber, als ja die Internationalen Kongresse für angewandte Chemie aus Anregungen hervorgegangen sind, die mein Kollege Regierungsrat Strohmer zunächst für die internationale Behandlung von Fragen der Zucker-Chemie gegeben hat. Wir freuen uns zu sehen, dass eine Veranstaltung, welche zum Teil von Oesterreich aus angeregt worde, so kräftig empor geblüht ist.

In den Vereinigten Staaten hoffen wir, vieles für uns Neue und Interessante zu hören und zu sehen. Die Wissenschaft und Industrie haben sich in Amerika vielfach etwas anders entwickelt, als in Europa. Dies ist sowohl eine Folge der Verschiedenheit der natürlichen Bedingungen als auch des Einflusses der Ueberlieferungen der Vergangenheit, welche auf die Gegenwart nachwirken. Während die Zustände in Europa das Ergebnis einer mehr als zweitausendjährigen Geschichte sind, sind die Vereinigten Staaten innerhalb weniger hundert Jahre aus einem Urwald zu einem hochkultiviertem Land geworden. In Europa stand alles unter dem Einfluss starkgefügter staatlicher Organisationen

zu einer Zeit, wo die Besiedler Amerikas alles durch die Tatkraft der Einzelnen schaffen mussten. So hat sich Amerikas kräftige Eigenart entwickelt.

Zwar befördert jetzt die Erleichterung des Verkehrs durch Verbesserung der Verkehrsmittel die persönliche Berührung der Angehörigen der verschiedenen Länder. Auch wir Oesterreicher haben ja das Vergnügen, zahlreiche Amerikaner in unserem Lande begrüssen zu können. Diese persönlichen Berührungen tragen naturgemäss dazu bei, die Verschiedenheiten der einzelnen Länder auszugleichen. Aber immerhin ist auch heute noch eine Reise von Europa nach Amerika nicht so leicht zu machen, wie eine Reise von New-York nach Chicago oder von Wien oder Prag nach Paris oder London. So sind denn die Unterschiede zwischen den Auffassungen und Arbeitsmethoden in Amerika und in Europa (insbesondere im continentalen Eurpa) noch keineswegs verwischt, zeigen ja doch selbst die einzelnen europäischen Staaten sehr wesentliche Verschiedenheiten. Und es ist gut, dass diese Verschiedenheiten bestehen. Denn die Möglichkeit, verschiedene Zustände zu vergleichen, bietet jedem Lande einem kräftigen Ansporn zu weiteren Fortschritten.

Wir haben noch immer alle Ursache zu bewundern, mit welchen Riesenschritten sich in den Vereinigten Staaten alles entwickelt, dank der Tatkraft ihrer Bewohner. So hoffen wir hier wertvolle Eindrücke zu bekommen, die uns in unserer Heimat nützlich sein werden. Die Vereinigten Staaten haben an der Entwicklung der menschlichen Kultur bereits einen sehr wichtigen Anteil genommen. Möge dieses Land auch in Zukunft in eben so reichem Mass zu den Fortschritten der Menschheit und insbesondere auch unserer Wissenschaft beitragen wie bisher!

RESPONSE OF PROFESSOR LEON LINDET:

Monsieur le President du Congres, Mesdames, Messieurs:

Une douce emotion, dans la quelle nos souvenirs d'histoire se trouvaient mêles a nos sentiments de fierté nationale, s'est emparée de nous, chimistes francais, quand nous avons aborde le sol américain. Notre pensée a été vers ceux qui, à une époque

déjà lointaine, sont venus à vos cotés, defendre la cause de la Liberté, et ont, de ce fait, créé, entre nos deux nations, des liens de sympathie et d'amitié, dont nous venons aujourd'hui affirmer la perpétuité.

Mais le temps ont changé depuis le jour où le courage de vos genéraux et de nos officiers reunis assuraient votre indépendance. Nous avons appris à mieux connaitre ceux que nos glorieux ancêtres ont combattus, et nous sommes heureux aujourd'hui de posséder leur amitié. Nous n'arrivons donc pas parmi vous avec l'attitude belliqueuse d'un Lafayette ou d'un Rochambeau; nous venons prendre contact avec les hommes de science du Monde entier, réunis par vos soins sur le sol de votre Patrie; nous venons apporter notre contribution d'efforts scientifiques a l'oeuvre commune du Congrès, et profiter des résultats que les chimistes des autres nations vont nous faire connaitre.

N'est-il pas curieux et intéressant de voir le Monde, entrainé par deux mouvements irrésistibles et contradictoires: Tandis que chaque nation se montre jalouse de son indépendance de sa personnalité politique, les idées se fusionnent au contraire dans un Idéal, qui repond aux mêmes besoins pour tous; l'indépendance intellectuelle et sociale s'efface devant la solution des mêmes problemes, qui ne peuvent etre résolus que par les mémes moyens; nous oublions nos nationalités, nos compétitions et nos vieilles querelles, et devenons solidaires pour le plus grand Bien de l'Humanité.

C'est à la Science que nous devons d'avoir bouleversé ces frontières morales; qu'elle s'inspire de la Chimie, de la Physique, de la Mathématique, de la Médecine, de l'Hygiene ou de la Sociologie, cette Science est Une, parceque la Vérité, à la recherche de la quelle elle consacre ses efforts, est Une également.

Les Congrès internationaux, qui se multiplient chaque année, nos congrès de Chimie appliquée, ont donc leur place et jouent leur rôle bien faisant dans cette évolution humaine vers un avenir meilleur, dont chacun de nous profite. En étudiant le mécanisme dont naîtront les découvertes industrielles, nos congrès assurent la prospérité de nos usines, et par conséquent la satisfaction des consommateurs et le soulagement de nos ouvriers. En fixant l'unification des méthodes d'analyses employees dans les transactions commerciales, ils établissent entre vendeurs et acheteurs, des sentiments de loyauté, qui se transforment en une estime mutuelle. Les sympathies et les amitiés qui s'établissent dans ces rencontres internationales, nous preservent peut-etre du fléau de la Guerre, mieux que ne le ferait un traité ou une convention diplomatique. Nous avons donc conscience de travailler pour la prospérité de l'Industrie et du Commerce; mais nous avons aussi la joie de travailler pour la Paix universelle.

Au nom des chimistes francais, présents ou absents, qui ont bie voulu m'honorer de leur confiance, en me déléguant parmi vous, j'addresse Nos respecteuse salutations a M. le President des Etats Unis, et remercie M. le Dr. Nichols. Je salue le grand peuple Américain dont on nous a appris, dès notre jeunnesse, à suivre l'admirable développement, et qui, dans la personne de ses savants et de ses industriels, nous fait aujourd'hui un si aimable accuei.

Vous avez, Messieurs, dans la préparation du Huitième congrès mis à contribution votre esprit d'initiative et d'organisation nous sommes, dès á present, certains que la réunion de 1912 occupera une grande place dans l'histoire des congres internationaux de chimie appliquée, et apportera, aux problèmes qui nous occupent, les solutions que la Science et l'Industrie universelles attendent de nous.

RESPONSE OF PROFESSOR DR. VON BUCHKA:

Herr President, Hochverehrte Damen und Herren:

Im Auftrage der Kaiserlichen Deutschen Reichsregierung sowie derjenigen Deutschen Bundesstaaten welche durch besondere Abgeordnete hier vertreten sind, und zugleich auch im Namen aller deutschen Fachgenossen welche hier erschienen sind, sage ich dem Komitee für den Achten Internationalen Kongress fur angewandte Chemie den verbindlichsten Dank für die an uns ergangene Einladung. Sie können aus der grossen Zahl von Gelehrten, von Vertretern der Industrie sowie von Abgeordneten der Behörden die aus Deutschland hierher geeilt sind, ersehen

welche Bedeutung in unserer Heimat diesem Congress beigelegt wird.

Der Austausch der Ergebnisse der wissenschaftlichen Forschung ist ein guter alter Brauch zwischen den befreundeten Nationen der Vereinigten Staaten von Nord Amerika und Deutschland. Gar mancher Ihrer amerikanischen Fachgelehrten hat seine Studierzeit an Deutschen Universitäten oder Hochschulen zurückgelegt. Umgekehrt hat gar mancher deutsche Chemiker hier seine Kenntnisse und sein Wissen zu vermehren Gelegenheit gehabt. Eine besondere Förderung hat dieser gegenseitige wissenschaftliche Meinungsaustausch erfahren seitdem hervorragenden Gelehrten beider Nationen Gelegenheit gegeben wurde die Ergebnisse ihrer wissenschaftlichen Forschung an den Universitäten der anderen Nation vorzutragen. Es war ein Ereignis für die chemische Welt Deutschlands als vor einigen Jahren Ihr hervorragender Atomgewichtsforscher seine Arbeitsweise in Berlin lehrte und die Schüler in die Welt der kleinsten Teilchen einführte eine Frage die nicht nur in wissenschaftlicher Hinsicht sondern wie alle wissenschaftlichen Unterlagen, auch für die chemische Industrie die allergrösste Bedeutung besitzt.

Wenn nun auch diese Unterlagen für die chemische Industrie aller Nationen die gleiche Bedeutung besitzen so hat dennoch die Industrie eines jeden Landes daneben ihre Eigenart bewahrt mag diese nun durch die Besonderheit der verarbeiteten Rohstoffe, durch ihre geschichtliche Entwickelung oder durch die Gunst anderer Umstände bedingt sein, und die gegenseitig kennen zu lernen wichtig ist. In Ihrem mit Naturschätzen so reich gesegneten Lande bewundern wir neben der Mannigfaltigkeit dieser Rohstoffe vor Allem die Grossfügigkeit mit welcher Sie an die Lösung gewerblicher Fragen herantreten.

Indem die Regierung alle diese Bestrebungen und die Beteiligung an solchen Congressen fördert dient sie zugleich auch der Gesamtheit. Denn es ist als ein wesentlicher Punkt bei diesen Congressen anzusehen dass sie nicht nur die Nationen des gesamten Erdballs zu friedlicher gemeinsamer Arbeit vereinigen sondern dass sie auch den einzelnen Teilnehmern Gelegenheit geben, die Eigenart der anderen Nationen besser kennen und richtiger würdigen zu lernen. Möchte der jetzt begonnene Congress

auch nach dieser Richtung von dem gewünschten besten Erfolge gleitet sein.

RESPONSE OF SIR WILLIAM RAMSAY:

Mr. President, Ladies and Gentlemen:

In the name of the British Empire and of its representatives in this place, I have the honour to thank you, Dr. Morley and Dr. Nichols, Honorary and Acting President of this Eighth Congress, for the cordial welcome which you have extended to us. Descended from common ancestors, having history, tradition and literature in common with you Americans, we always feel towards our Trans-Atlantic cousins feelings deeper than ordinary friendship, feelings crystallized in the old proverb—"Blood is thicker than water." We regret with you the enforced absence of the Head of your State, but rejoice that his health will permit us to pay to him our respects this afternoon, at the White House.

Like former Congresses, this one, I am certain, will have results not merely in promoting the welfare of our nations through, exchange of information regarding chemical industry, but also as on former occasions, of furthering feelings of mutual friendship toward our scientific brethren.

I especially wish to express our cordial thanks to Dr. Nichols, with whose work in organizing this Congress I have been kept in some measure in touch for the arrangements he has made for our comfort. Gratitude is a sense of favors to come, and our minds, Dr. Nichols, are filled with that sentiment, knowing that we may look forward to a most successful meeting.

RESPONSE OF DR. JOKICHIRO YEMORI:

Your Excellency, Mr. President, Ladies and Gentlemen:

I am deeply grateful of the honor of having received an invitation to speak to you, on behalf of the Japanese delegates, on this memorable occasion.

When the invitation to attend the Eighth International Congress of Applied Chemistry in the United States reached Japan, it was received with great enthusiasm and interest. No better place could have been chosen for the present Congress than the

United States where immense natural resources have been taken advantage of for the application of chemistry—no one, indeed, can help admitting the marvelous progress and wonderful development she has made in all branches of science and industry.

It is very fascinating to know for us delegates from the Far East that the place where we meet is in no great distance from the site where illustrious Priestley found his last resting place in the early dawn of modern chemistry and the American Chemical Society saw its first light of existence. The fact that the same society is now supported by a strong force of several thousands of members and that it is comparable with any largest of its kind on earth, amply testifies the status of chemical science in this country—not even mentioning the several allied societies and associations with according members of many thousands.

Quite apart from the thought that "Science is no legacy to a particular nation," we cannot help feeling grateful for what your country has done directly or indirectly in furtherance of the science in our country.

Progress of Chemistry as a science and its application to all branches of industry is showing modest yet steady strides in Japan; it has been in fact one of the most important factors in bringing our country to its present state, and we hope that in no remote future we may be able to offer a cordial invitation to the Congress to have its meeting in Japan.

I take this opportunity of expressing to you our sincere gratitude for your hearty welcome and cordial hospitality, and at the same time to express our confident hope that the gathering of such distinguished people from all over the world will give the most beneficial results for the promotion of the universal civilization.

RESPONSE OF COMMANDITORE GIACOMO CIAMICIAN:

Signor Presidente:

Porgo a Vostra Eccellenza il saluto del Governo Italiano che assieme al Collega Prof. Giuseppe Bruni ho l'onore di rappresentare.

Sono poi veramente lieto che l'Ottavo Congresso Internazionale

di Chimica Applicata si svolga negli Stati Uniti e che io abbia la fortuna di poter rivolgere ai Colleghi d'America i saluti dei Chimici Italiani e piú specialmente di quelli della nostra Societá Chimica e dell'Associazione Chimica Industriale di Torino.

L'Italia che fu sede dell'antica civiltá e ne tenne alta in tutti i tempi la fiaccola, gareggiando con le altre Nazioni sulla via del Progresso, ammira il vostro grande Paese che é l'espressione della civiltá piú nuova e piú cospicua.

Le grandi risorse di cui esso dispone ed il genio speciale e l'attivitá dei suoi abitanti hanno impresso un carattere peculiare alla vita americana che pulsa piú rapida e piú intensa che nelle nostre contrade. Il contrasto peraltro predispone sovente alla simpatia e d'altronde l'Italia, malgrado la sua lunga cultura é giovane pel suo risorgimento.

In molti campi del Progresso Scientifico e pratico il genio italiano e quello americano si sono avvicendati. É superfluo che io qui ricordi che i nomi America e Colombo richiamano alla nostra memoria periodi di grandi ardimenti e suonano cari tanto al nostro quanto al vostro orecchio. La scintilla che Franklin strappó al Cielo serve ora per opera di Marconi a congiungere per vie invisibili i naviganti ai Continenti come la corrente di Galvani e di Volta venne dal vostro Edison piegata alle esigenze della vita moderna.

La Universitá presso cui siederá questo Congresso porta il nome di Columbia ed io sono ben lieto di porgere a questa piú giovane sorella americana dal nome italico i saluti della vecchia Alma Mater di Bologna.

L'edificio in cui sono raccolte le memorie dei fasti degli Stati Uniti e dove pulsa rigogliosa la vita politica della Repubblica ha un nome fatidico dell'antica Roma: a similitudine dei riti antichi ascenderemo oggi il Campidoglio per propiziarci gli Dei a fine che ben riescano i lavori del Congresso.

RESPONSE OF PROFESSOR PAUL I. WALDEN:

Hochgechrte Herren Presidenten! Hochzuverehrende Damen and und Herren,

Weither vom Osten Europas und über den Ozean bin ich hierhergekommen, um im Namen der Regierung Russlands und

der Chemiker unseres Landes an dem VIII Internationalen Kongress für angewandte Chemie teilzunchmen. Indem ich Ihrem grossen Lande unsere tiefe Hochachtung bezeuge, überbringe ich den Chemikern Amerikas ehrerbietige Grüsse und dem VIII Kongress die aufrichtigsten Glückwunsche! Füw rahr wir alle sind hier zu einem grossen Fest der Wissenschaft versammelt, einem Fest, das uns alle eint und mit Stolz erfüllt. Ist doch moderne die Chemie eine Wissenschaft der Wunder, und leben und schaffen wir alle inmitten dieser wunderbaren Zeit! Mutet es nicht wunderbar an, wenn wir uns erinnern, wie einst die Chemikr e im Verborgenen, in höhlenartigen Räumen wirkten und nach den Geheimnissen der Natur forschten, während heutzutage *wir* in chemischen Palästen arbeiten and unsere Blicke immer mehr zum Licht, immer höher hinauf, zum Luftmeer und den fernen Himmelskörpern richten dürfen,—die Fürsten und Machthaber der verschiedenen Reiche nehmen unsere Versammlungen unter ihren persönlichen Schutz and laden uns festlich zu Gaste. Und muss es uns in dieser feierlichen Versammlung nicht mit einem Gefühl des Stolzes and Glückes erfüllen, feststellen zu können, dass die Träume und Hoffnungen der Chemiker von einst, nunmehr schon greifbare Gestalt angenommen haben, jene Geheimnisse des „Steins der Weisen" heutzutage zum grossen Teil schon entschleiert worden sind; denn was wollten sie anderes, als Gewalt gewinnen über die Kräfte und Schätze der Natur, um das Leben der *Menschen* zu verlängern sie vor Krankheit zu schützen, zu veredeln und zur freien Betätigung ihrer Kräfte, auf Wohle der *Menschheit,* allendlich fähig zu machen?

Von jeher waren es die Sterne, welche der Menschheit Blicke auf sich lenkten. Das Symbol *Ihres* Landes, das Banner mit den vielen Sternen, hat schon lange die Blicke der alten Welt gefesselt: heute sind wir Chemiker der alten Welt *diesen* Sternen gefolgt, und Tausende sind augenblicklich, zu gemeinsamer grosser Arbeit auf dem Gebiete der *gesamten* Chemie, unter dem Schutze derselben versammelt. Mögen *sie* für unser Werk wahre Glückssterne sein! Möge der VIII internationale Kongress für angewandte Chemie in würdiger Weise seinen Vorgängern sich anschliessen und damit das hohe Ziel der Veredlung und Einigung der Menschen sichtbar fördern! Möge unser gemeinsames Wirken neue Bausteine beisteuern zu einem Denkmal, das dereinst, neben Ihrer Freiheitsstatue, als eine Statue des Glückes errichtet werde mit der Inschrift des Idealisten Ulrich von Hutten: „*Es ist eine Lust zu leben.*"

RESPONSE OF PROFESSOR F. P. TREADWELL.

Herr Präsident, sehr geehrte Damen und Herren!

Im Namen der Schweizerischen Eidgenossenschaft, der Eidgenössischen Technischen Hochschule und der Schweizerischen Gesellschaft für Chemische Industrie, habe ich die Ehre dem Komitee des 8. Internationalen Kongresses für angewandte Chemie den verbindlichsten Dank auszusprechen für die an uns ergangene Einladung.

Für mich, der ich geborener Amerikaner bin, ist es eine ganz besondere Freude, dass es mir nach fast dreissigjähriger Abwesenheit beschieden ist, das Land meiner Geburt wieder zu betreten, in dem es so viel Hervorragendes zu schauen und so viel Tüchtiges zu lernen gibt.

Mit den Grüssen der schweizerischen Republik überbringe ich zugleich die Versicherung ihrer Freundschaft und Sympathie für dieses grosse Land, das auf allen Gebieten so Glänzendes leistet. Wie sehr die grossartigen Erfolge in Technik und Wissenschaft, die die Amerikanische Union zu verzeichnen hat—ich erinnere nur an den mächtigen Aufschwung in der Eisen- und Aluminiumindustrie, an die bedeutenden wissenschaftlichen Arbeiten, die alljährlich auf Ihren Hochschulen ausgeführt werden—die Bewunderung der ganzen Welt erregen, das haben meine Herren Vorredner bereits hervorgehoben und so bleibt mir nur der Wunsch auszusprechen: May the bands of friendship between the great American Union and her little European sister become stronger and stronger and never be severed!

[NOTE.—The responses of Professor Belisario Diaz-ossa for the South American Republics and of Dr. Samuel Eyde for other countries had not come to hand when this volume went to press, March 20, 1913.]

A telegram was read by President Nichols from Dr. Henry M. Howe, President of the International Association for Testing Materials as follows:

"Dr. William H. Nichols, *President,*
"Eighth International Congress of Applied Chemistry
"Washington, D. C.

"Most cordial greetings and best wishes for a successful meeting.

"International Association for Testing Materials.
"H. M. Howe, *President.*
"E. Reitler, *Secretary.*"

In accordance with a resolution unanimously voted by the Congress, the following response was sent to Dr. Howe:

"Washington, September 4, 1912.

"The President and the Eighth International Congress of Applied Chemistry at their inaugural session acknowledge your greetings with great appreciation, and offer to the Congress of Testing Materials hearty good wishes."

The Acting Secretary, reported from the Committee on Emblems of the Congress, the following resolution, which was unanimously adopted:

"*Resolved,* That a badge of the Congress, and only one, shall be made in gold."

Dr. George F. Kunz, Chairman of the Committee on Badges offered a resolution that the only gold badge of the Congress be presented to President William H. Nichols as a tribute of the Congress to the loyal and energetic support, with which he inspired the work of preparation during the last three years. This resolution was unanimously adopted and the badge was presented to Dr. Nichols by Miss E. C. Day of the Local Committee.

Dr. Harvey W. Wiley, Chairman of the Washington Committee of Arrangements was recognized and offered a resolution of thanks to the National Society of the Daughters of the American Revolution for the use of Continental Memorial Hall for the inaugural meeting of the Congress. The resolution was unanimously adopted.

At the close of the proceedings, the United States Marine Band, under the leadership of Prof. William H. Santelmann rendered the national anthem of the United States, the audience standing, after which the meeting terminated.

Reception by the President of the United States

At 4.30 o'clock, the Congress convened by invitation of the President in the East Room of the White House, where the President, although incapacitated for standing on his feet, delivered his address of welcome, after which he received each member of the Congress on the White House lawn. The reception included, in addition to the usual features, a concert by the United States Marine Band until six o'clock and a piano recital by Miss Agnes Hope Pillsbury.

Other Social Features of the Washington Meeting

In addition to many private dinners, the Congress was received formally by the Secretary and Board of Regents of the Smithsonian Institution in the new building of the United States National Museum, where, in addition to the inspection of exhibits, a concert was rendered by the United States Marine Band, assisted by Mrs. Bertha Lincoln Huestis, vocal soloist.

Visits to Laboratories and Other Institutions

September 5. A program of inspection of the various Government laboratories and private laboratories in Washington was arranged. Many of the members also took advantage of the opportunity arranged by the Committee for paying their respects to the historical residence of General Washington at Mount Vernon. The institutions visited are listed below:

Laboratories

United States Department of Agriculture.
Geophysical Laboratory of the Carnegie Institution.

United States Bureau of Standards.
United States Geological Survey.
United States Bureau of Mines.
United States Marine-Hospital Service.

Other Institutions

Mount Vernon.
United States Treasury Department.
Corcoran Gallery of Art.
Bureau of Printing and Engraving.
Smithsonian Institution.
Navy Yard.
Washington Monument.
Library of Congress.

At five o'clock the official excursion trains departed for New York.

Representation at Washington

The registrations at Washington included:

Foreign members	233
Members from the United States	339
Total	572

The official representation of the Congress at Washington was as follows:

Patron, The President of the United States.
Honorary President, Edward W. Morley.
President, William H. Nichols.
Treasurer, William J. Matheson.
Acting General Secretary, David T. Day.

THE GENERAL LECTURES

These were four in number and were delivered before distinguished and most interested audiences in the Great Hall of the College of the City of New York.

The text of these General Lectures appears below.

Each General Lecture was preceded by an Organ Recital the programs of which are also given and was succeeded by an informal tea and reception on the lawn of the College of the City of New York.

General Lecture of Friday, September 6, 1912.

Program of Organ Recital

Mr. Mark Andrews, *Organist.*

1	"Fiat Lux"	*Bubois*
2	"In Paradisum"	*Bubois*
3	Sonata in D minor (a) Allegro (b) Pastorale	*Guilmant*
4	"The Swan"	*Saint-Saens*
5	Capriccio	*Lemaigre*
6	Matin Provençal	*Bonnet*

Address of Gabriel Bertrand, Paris

SUR LE ROLE DES INFINIMENT PETITS EN AGRICULTURE.

Je me propose d'examiner, dans cette Conference, une des questions nouvelles-les plus intéressantes au point de vue théorique et pratique que soulève l'étude de la composition chimique des espèces végétales: je veux dire la question du rôle joué par certains corps, métalloïdes et métaux, que l'on trouve seulement dans les plantes en très petites proportions.

Les premiers phytophysiologistes dont les recherches aient

porté sur la composition élémentaire des végétaux n'ont pas tardé à tomber d'accord pour reconnaitre qu'ne dizaine environ de corps simples était nécessaire à l'édification des tissus et au fonctionnement des cellules; l'*hydrogène* et l'*oxygène*, dont l'association forme l'eau, soit les 75 à 95 centièmes du poids total des plantes vivantes; le *carbone*, qui, lié aux deux précédents, constitue la cellulose, le sucre, les graisses et les autres substances dites hydrocarbonées; l'*azote*, qui entre avec les précédents dans la composition de l'albumine, du gluten et des matières protéiques, ainsi que le *soufre* et quelquefois le *phosphore.* Enfin, le *potassium,* le *calcium,* le *magnésium,* de petites quantités de *fer*.

L'ensemble de ces dix éléments, de ces dix corps simples, est absolutement nécessaire au développement normal des plantes. L'absence d'un seul entraine la non-utilisation des autres et l'arrêt de la croissance.

Si l'on dispose convenablement dans un vase rempli d'eau pure une graine de haricot, de maïs, d'avoine, de sarazin, etc., on assiste, à la germination: une petite plante apparait, se développe aux dépens de l'eau et des substances apportées par la graine, aux dépens aussi de l'acide carbonique contenu dans l'atmosphère, mais ce phénomène de végétation dure seulement quelques jours; faute d'autres aliments, la jeune plante ne tarde pas à mourir.

Au contraire, si on remplace l'eau pure par une solution renfermant, à l'état de sels, de l'azote, du soufre, du phosphore, du potassium du calcium, du magnésium et un peu de fer, la plante se développe normalement, elle produit des fleurs et des graines et, lorsqu'on sait s'y prendre, la récolte ne le cede en rien à celles que l'on obtient en pleine terre dans les conditions ordinaries.

L'experience recommencée encore mais en supprimant de la solution nutritive l'un quelconque des éléments dont l'ensemble avait produit un si beau résultat, donne des récoltes misérables, analogues à celles de l'eau pure.

D'autre part, si on fait, l'analyse complète d'un végétal et qu'on additionne les poids de chacun des éléments trouvés, on obtiente, en tenant compte de tous ceux énumerés plus haut, un chiffre voisin de 99,9% du poids total.

De sorte que, à environ un millième près, les plantes sont constituées par la réunion de six métalloïdes et de quatre métaux, que ces métalloïdes et ces métaux suffisent à former, par leurs multiples combinaisons, les énormes quantités de sucre, d'amidon, de cellulose, d'huile, etc., que l'industrie sépare ou transforme, de toutes les substances aussi que l'homme et les animaux tirent du règne végétal pour les besoins de leur alimentation journalière.

Ces notions, malgré leur simplicite, sont fondamentales pour l'Agriculture. Il est bien évident, en effet, que l'on doit assurer à la plante la provision de chacun des éléments qui lui sont nécessaires si l'on veut obtenir de belles recoltes.

Comme dans les expériences de tout à l'heure, il n'y a pus, en grande culture, à se préoccuper du carbone, que la plante trouve toujours dans l'atmosphère en quantité superieure à tous ses besoins. Pourvu que le sol reçoive une proportion d'eau suffisante, sous forme de pluie ou par irrigation, il reste seulement à compter avec les autres éléments. Encore, dans la plupart des cas, la terre est elle si riche en composés du calcium, du magnésium, du fer, du soufre, que l'agriculteur n'a plus à subvenir qu'au manque de potassium, d'azote et de phosphore. C'est ce qu'il fait à l'aide des engrais. En ajoutant des quantités convenables de nitrates, de phophates, de sels ammoniacaux et potassiques, il complète l'approvisionnement alimentaire du sol et permet à la plante de prélever en proportions utiles tous les materiaux de sa construction.

Ce sont surtout les recherches de Duhamel, de de Saussure, de Sachs, de Boussingault, de Liebig, de Georges Ville, qui nous ont fait connaitre cette théorie des engrais dont la grande valeur pratique est confirmée aujourd'hui par tous les agronomes.

Aussi évidente et aussi féconde qu'elle soit, cette théorie ne tient pas compte, principalement dans son application usuelle, de tous les résultats obtenus dans l'étude de la composition des végétaux; elle néglige ceux qui, ajoutés aux 99,9% d'éléments déjà considérés, permettraient d'atteindre le total de 100% d'une analyse parfaite.

De quels corps est formée cette minime fraction qu'il nous faut maintenant examiner? Tout d'abord, comme on l'a très souvent vérifié, de *silicium*, de *chlore* de *sodium*, de *manganèse* et d'*aluminium*. C'est vous dire qu'il y a dans les plantes très peu de chacun de ces corps simples, souvent moins d'un 1/10.000 et même d'un 1/100.000. Les végétaux qui croissent au bord de la mer et à plus forte raison dans celle-ci, comme les Fucus et d'autres algues, renferment beaucoup plus de chlore et de sodium que les autres; les graminées, les cypéracées, les équisétacées, sont relativement riches en silicium; on peut aussi trouver des espèces contenant plus que des traces de manganèse ou d'aluminium. Mais ce sont là des exceptions qui n'empêchent pas de considérer comme très général le fait que les plantes contiennent seulement des proportions très petites de chacun des cinq nouveaux éléments dont je viens de vous donner les noms.

Le silicium, le chlore, le sodium, le manganèse et l'aluminium sont en si petites proportions qu'il a été très difficile jusqu'ici de se former une opinion quant à leur valeur nutritive. La plupart des phytophysiologistes doutent de leur rôle, certains le nient d'une manière formelle. Ils supposent, pour expliquer la présence de ces éléments chez les plantes, que les racines sont capables d'absorber indiféremment touts les substances solubles contenues dans les milieux où elles se développent.

Arrivée déjà au nombre de 15, la liste des métalloïdes et des métaux rencontrés chez les plantes est-elle complète? Loin de là, elle ne représente que la moitié environ de tous les corps simples que les méthodes d'analyse, chaque jour plus perfectionnées, ont fini par porter à notre connaissance.

L'*iode* et le *brome*, reconnus d'abord dans les plantes marines, mais dont il y a aussi, d'après Chatin et surtout Bourcet, des traces dans toutes les autres. Le *fluor*, que Salm Horstmar a signalé dans l'orge et dans le pois. L'*arsenic* trouvé récemment dans quelques algues marines par Tassilly et Leroide. Le *bore*, reconnu notamment dans le vin, où on le croyait alors d'origine frauduleuse. Et parmi les métaux, le *rubidium* et le *coesium*, signalés par Grandeau dans la betterave, le *lithium*, découvert par Bunzen et Kirchhoff dans plusieurs végétaux des environs de Heidelberg; le *strontium*, rencontré par Forchammer dans le Fucus vesiculosus; le *baryum*, mis en évidence par Scheele dans les cendres de divers arbres et arbrisseaux, aussitôt après sa découverte dans la magnésie noire; le *zinc*, que l'on a d'abord trouvé dans les plantes des terrains calaminaires; le *cuivre*, frequément reconnu par Vauquelin, Sarzeau, Guérithault et d'autres encore; le *cobalt*, trouvé dans la zostère marine et même l'*argent*, dans les fucus, d'après Malaguti, Durocher et Sarzeau. Enfin, le *vanadium* et le *cérium*, signalés, il'y a deux ou trois ans, par Demarçais.

C'est à dire qu'aux 15 éléments déjà énumérés, il faut en ajouter encore 16 autres, ce qui nous donne une liste de 31 éléments sur les 80 et quelques, actuellement connus.

Ce résultat général de l'analyse chimique des végétaux est vraiment digne de fixer l'attention. S'il est exact, en effet, que tous ou presque tous les éléments découverts dans les plantes entrent dans la constitution de leurs tissus ou interviennent dans leurs échanges nutritifs, il faut admettre que les végétaux possèdent une composition beaucoup plus complexe qu'on pouvait d'abord l'imaginer. Or, plus cette composition est complexe, plus augmente l'épaisseur du voile qui nous cache l'origine du monde végétal, plus deviennent nombreuses les difficultés qui entourent la solution d'une foule de problèmes relatifs à la physiologie des plantes.

Mais procédons systèmatiquement et n'anticipons pas sur les faits. Voyons, avant d'aller plus loin, si des éléments comme l'aluminium, le manganèse, le zinc, le bore, le silicium, etc., dont la proportion est si petite qu'elle a passée longtemps inapercue, peuvent être des éléments physiologiques, c'est-à-dire nécessaires à la croissance de la plante, et non pas comme on l'a soutenu, des corps étrangers, introduits par un simple phénomène d'osmose à travers les racines.

Pour cela, prenons comme exemple le cas du manganèse, le mieux étudié et le plus démonstratif.

Le manganèse parait exister chez tous les végétaux. Observé déjà par Scheele dans les cendres du cumin sauvage et dans celles du bois, il a été reconnu ou dosé depuis dans une foule de graines, de racines, de feuilles ou de plantes entières. Sa proportion varie beaucoup suivant les espèces et suivant les organes; elle est, en tous cas, fort petite, souvent inférieure au 1/100.000 et même au 1/1.000.000. C'est donc bien un élément qui, s'il est nécessaire au fonctionnement physiologique de la plante, peut être considéré comme le type de ceux dont nous recherchons la valeur.

Très frappé par la présence du manganèse dans les plantes, Sachs avait essayé, vers 1860, à l'aide de la méthode de culture en solutions salines, si ce métal était de quelque utilité pour les plantes supérieures; il n'en avait pas trouvée. Plus tard, en 1870, Raulin avait examiné la même question à propos d'une moisissure aujourd'hui bien connue des physiologistes, *l'Aspergillus niger;* il n'avait pas étè plus heureux.

Ces insuccès, obtenus par deux expèrimentateurs très habiles, ne suffisent pas à faire rejeter d'une manière définitive la valeur fonctionnelle du manganèse.

Presque tous les sels, même les plus purs fournis par le commerce, renferment des traces de manganèse. Il en résulte que Sachs et Raulin introduisaient, sans le savoir, du manganèse das tous leurs milieux de culture.

D'autre part, comme toutes les plantes, si elles utilisent ce métal, ne le font qu'à l'état de traces, il est possible qu'elles en aient trouvé assez dans les milieux témoins, préparés par Sachs et par Raulin, pour qu'une addition volontaire soit alors resté sans effet appréciable.

Ainsi, la méthode des cultures s'est montrée tout aussi incapable que la méthode chimique à nous faire savoir si le manganèse est de quelque utilité pour la plante.

Heureusement, une série de recherches, n'ayant d'ailleurs à l'origine aucun rapport avec la question qui nous occupe, est venue apporter à celle-ci un argument décisif.

Tout le monde connait les admirables bibelots de laque dus à la patience et au talent des artistes japonais. Ces bibelots, comme le magnifique vernis utilisé presque partout en Extrême-Orient pour recouvrir de petits meubles, des plateaux, des boites et une foule de menus objets, sont préparés avec une espèces de lait d'origine végétale. Ce lait, ou latex, s'écoule lorsqu'on pratique des incisions à travers l'écorce de différentes espèces d'arbres appartenant du genre *Rhus*. Il est d'un blanc un peu jaunâtre et possède la propriété curieuse de se colorer au contact de l'air, en brun, puis en noir d'ébène; en même temps, il se transforme en une substance très rèsistante aux réactifs et susceptible d'un beau poli.

Ce phénomène est dû à l'oxidation du latex sous l'influence d'un principe spécial, facile à extraire, que j'ai étudié sous le nom de *laccase.*

Or, la laccase n'est pas seulement présente dans le latex de l'arbre à laque, elle est pour ainsi dire universellement répandue chez les végétaux ou elle joue le rôle capital d'intermédiaire entre l'oxygène, contenu dans l'atmosphère, et diverses substances organiques, renfermées dans les cellules.

Je puis vous montrer par quelques expériences d'abord le puovoir oxydant de la laccase, puis l'existence de ce principe immédiat dans les plantes.

Chacun des petits appareils que voici est essentiellement constitué par deux tubes de verre soudés l'un à l'autre. Dans le petit, on met quelques gouttes de solution de laccase, dans le grand, un certain volume de solution ou d'émulsion du corps à oxyder. L'appareil étant garni, on y fait le vide avec une trompe à mercure, de façon à n'y laisser aucune trace d'air, puis on le ferme à la lampe.

Vient-on maintenant à retourner l'appareil, le contenu de chacun des tubes s'écoule et se mélange à l'autre; mais, comme il n'y a pas d'air, il ne se produit aucune transformation chimique.

Dès, au contraire, qu'on laisse pénétrer l'air en brisant la pointe de l'appareil, la réaction commence et le corps oxydable se colore peu à peu. Si l'on a pris le laccol, retiré du latex de l'arbre à laque où il accompagne la laccase, il y a coloration brune, puis noire.

Avec le tanin des marrons d'Inde, des pommes, etc., la coloration est rouge brun.

La résine de bois de gayac devient d'un beau bleu, et ainsi de suite, selon la nature de la matière organique oxydable.

On peut, en se servant d'une solution alcoolique de résine de gayac, démontrer très facilement, d'une manière directe, l'existence de la laccase dans les tissus végétaux, à condition que ceux-ci ne soient pas trop colorés.

Je verse quelques gouttes de solution de gayac sur la section d'une pomme de terre, d'un champignon, d'une pomme; vous allez voir apparaitre lentement aux endroits où il y a de la laccase, une coloration bleue caractéristique.

Lorsque le tissu végétal est coloré, comme celui des feuilles, on ne peut évidemment employer le procédé simple que je viens de vous montrer. Il faut recourir à la mèthode générale, c'est-à-dire, à l'extraction de principe oxydant.

Voici maintenant comment la connaissance de la laccase et de son importance physiologique se rattache au sujet de notre Conférence.

En poursuivant l'étude du principe oxydant de l'arbre à laque, j'ai trouvé qu'il était dû à la combinaison d'une matière organique particulière, jouant le rôle d'un acide très faible, avec une petite quantité de manganèse, la quantité de métal contenue dans une préparation de laccase retirée de l'arbre à laque du Tonkin, était de 0,12%.

Cette petite quantité de métal est indispensable au fonctionnement chimique de la laccase. Si on lui enlève, elle perd la propriété d'agir comme fixatrice d'oxygène.

Il faut d'ailleurs remarquer que tous les sels manganeux jouissent, à un degré plus ou moins grand, du caractère essentiel de la laccase. Le tableau numéro I montre que pour différents sels la puissance oxydante augmente en sens inverse de la force de l'acide auquel le métal est combiné. Ainsi plus l'acide est faible, plus le pouvoir oydasique est grand et l'on comprend ainsi que la laccase soit parmi les combinaisons les plus actives.

Il est facile d'imaginer par quelle série de réactions une quantité indéfinie d'oxygène est fixée sous l'influence de la laccase ou d'un sel quelconque de manganèse.

La combinaison manganeuse, que nous pouvons représenter schématiquement par la formule:

$$RMn$$

est d'abord hydrolysée, du moins en partie, par l'eau dans laquelle elle est dissoute. Il en résulte un mélange d'acide libre et de protoxyde de manganèse

$$(1) \qquad RMn + H_2O = RH_2 + MnO$$

Le protoxyde de manganèse est une combinaison très oxydable. Au contact de l'air, il se transforme en bioxyde. Cette propriété est même la base du procédé Weldon pour la régénération industrielle du bioxyde servant à préparer le chlore. Pendant cette oxydation:

(2) $MnO + O_2 = MnO_2 + O$

la molécule d'oxygène est scindée en deux atomes, atomes non saturés, et par conséquent, plus actifs; l'un d'eux est nécessairement fixé par une molécule de protoxyde de manganèse mais l'autre peut se fixer soit sur une seconde molécule de MnO, soit sur autre corps oxydable, comme celui du latex de l'arbre à laque, ou bien encore sur la résine de gayac, l'hydroquinone, etc., qui seuls, résisteraient au contact de l'oxygène moléculaire.

Cette phase réactionnelle étant atteinte, on se trouve en présence d'acide libre, de bioxyde de manganèse et d'un excès de corps oxydable.

Grâce à ce dernier, dont la chaleur d'oxydation s'ajoute à celle de formation du sel manganeux, il y a réaction entre l'acide et le bioxyde:

(3) $RH_2 + MnO_2 = RMn + H_2O + O$

L'atome d'oxygène libéré se fixe sur une nouvelle molécule du corps oxydable et la combinaison manganeuse primitive est régénérée.

Il suit de là qu'un poids déterminé, même très petit de composé manganeux, peut oxyder, aux dépens de l'oxygène atmosphérique, un poids illimité de corps oxydable. L'exactitude de cette interprétation a d'ailleurs été démontrée par l'expérience.

TABLEAU No. I.

Pouvoir Oxydant des Sels de Manganèse.

(vis-à-vis de l'hydroquinone)

En agitant pendant 20 heures, à la température de +14−15°, dans un ballon de 250 cc. de capacité, une solution de:

Hydroquinone	1 gr.
Eau distillée	100 cc.
Manganèse (sous forme de sel)	100 mgr.

les volumes suivants d'oxygène sont absorbés:

Avec	l'azotate de manganèse		1, cc. 4
—	le sulfate	—	1, 6
—	le chlorure	—	1, 8
—	le formiate	—	7, 4
—	le benzoate	—	15, 3
—	l'acétate	—	15, 7
—	le salicylate	—	16, 3
—	le lactate	—	17, 6
—	le gluconate	—	21, 6 (1)
—	le succinate	—	22, 1

Tableau No. II

Influence du Manganèse sur la Culture de l'Aspergillus Niger

(Gab. Bertrand et Javillier)

Cultures en matras de 2 litres.
Volume du liquide nutritif: 250 cent. cub.
Température: +32°.
Durée: 4 jours.

Quantités de manganèse introduites	Dilutions du manganèse	Poids secs des récoltes	Quantités de manganèse fixées.
0 (témoin)		1 gr. 331	0 mgr. 001
0 mgr. 5	1/500.000	1 490	0 030
1 mgr.	1/250.000	1 635	0 036
2 mgr. 5	1/100.000	1 700	0 056
10 mgr.	1/25.000	2 190	0 106
25 mgr.	1/10.000	2 380	0 190
100 mgr.	1/2.500	2 700	0 700
500 mgr.	1/ 500	2 765	4 000
1250 mgr.	1/ 200	3 510	10 000
2500 mgr.	1/ 100	3 390	22 000

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[1] Des cristaux de quihydrone apparaissent après 2 heures.

TABLEAU III

Influence du Manganèse sur la Culture de l'Avoine.

(Gab. Bertrand et Thomassin)

Surface de chaque parcelle: 20.000 mètres carrés.

Nature du sol: argileux, très faiblement calcaire. Contient 0,024% de manganèse soluble dans l'acide acétique au centième bouillant et 0,033% de manganèse soluble seulement dans l'acide chlorhydrique concentré chaud.

Engrais ajoutés par hectare: 1°, à chaque parcelle, 200 kg. de superphosphate minéral à 15% environ de P_2O_5 et 75 kg. de sulfate d'ammoniaque à 20,5 d'azote.

id. 2°, à la parcelle en expérience, 50 kg. de sulfate de manganèse à 31,58% de Mn.

	Sans manganèse	Avec manganèse
Poids total de la récolte	1.290 kg.	1.580 kg.
— à l'hectare	6.450 —	7.900 —
Poids après battage:		
Poids du grain	518 kg.	608 kg.
— à l'hectare	2.590 —	3.040 —
— de la paille et des balles	768 —	968 —
— à l'hectare	3.840 —	4.840 —
Analyse du grain:		
Poids de l'hectolitre	44 kg.	46 kg.
Eau à +110°	17,48%	16,85%
Cendres	2,82%	2,88%
Manganèse	0,000.004%	0,000.004%
Azote total	1,61%	1,58%
Différences en faveur du manganèse:		
Pour l'ensemble de la récolte	22,5%	
Soit pour le grain	17,4	
— — la paille	26,0	

Ainsi, d'une part, les végétaux qui ne pouvent se passer d'oxygène pour accomplir certaines transformations chimiques, utilisent la laccase comme intermédiaire dans ces transformations; d'autre part, la laccase est une combinaison de manganèse. *Les vegetaux ont donc besoin de manganese.*

De plus comme une quantité, même très petite du métal, suffit à fixer des quantités pour ainsi dire indéfinies d'oxygène, on peut admettre que *les végétaux n'ont besoin pour leur fonctionnement normal que d'une proportion très petite de manganèse.*

Il est possible de démontrer, d'une manière directe, l'exactitude de cette conclusion.

En se servant de sels purifiés par des méthodes spéciales, d'eau très pure, et en opérant dans des vases en quartz fondu, on prépare une solution nutritive pour ainsi dire rigoureusement exempte de manganèse.

Si on introduit alors dans cette solution des semences dela petite plante dont je vous ai parlé tout à l'heure, de l'*Aspergillus niger*, il y a germination et développement, mais on n'obtient qu'une très mince récolte. Par exemple, si on opère avec un quart de litre environ, 2 gr. $\frac{1}{2}$ à 3 gr. Mais si on recommence la culture en ajoutant à la solution nutritive 0 gr. 000.0025 de manganèse, la plante croit d'une manière si vigoureuse quelle atteint aisément le poids de 11 à 12 gr. Une quantité 10 fois et même 100 fois plus petite de manganèse donne encore des augmentations de récolte très appréciables.

Voilà donc établie, par des voies différentes, l'utilité pour le végétal, d'un élément dont la proportion est si petite qu'il pouvait nous sembler tout d'abord accidentel et sans aucune valeur physiologique.

L'état de nos connaissances n'est pas aussi avancé en ce qui concerne les métalloïdes et les métaux qui, en très petites proportions, accompagnent le manganèse. Nous n'avons guère de notions un peu étendues et bien solides que pour le zinc et pour le bore.

Comme vous le savez, Raulin a découvert, en poursuivant des recherches devenues classiques, qu'une minime proportion de zinc, environ 1/100.000 du milieu de culture, est nécessaire à la production de belles récoltes d'*Aspergillus*. On a dans la suite, expliqué ce résultat en admettant que le sel de zinc agit d'une manière indirecte en détruisant les microbes qui peuvent envahir le milieu et nuire au développement de la plante.

Un de mes collaborateurs, Javillier, a donné la preuve que cette interprétation est erronée, que le zinc fait partie de la composition de l'*Aspergillus* et agit sur sa croissance à la façon du manganèse. Il a montré, de plus, que le zinc se rencontre parmi les éléments habituels des végétaux et il a pu le doser dans un grand nombre d'espèces très différentes.

Un autre de mes collaborateurs, Agulhon, s'est livré à une enquête analogue au sujet du bore. Il a réussi à reconnaitre et même à doser ce métalloïde dans toutes les plantes qu'il a examinées.

D'autres recherches sont en cours, elles permettront de distinguer peu à peu les éléments dont l'existence est normale, de connaitre ensuite la part prise par chacun d'eux dans les phénomènes nutritifs de la plante. Il faudra, cela est certain, beaucoup de travail et de temps pour remplir ce programme de recherches, mais, déjà, nous pouvons considérer comme résolue la question fondamentale qui est le noeud même de cette conférence, à savoir que *des metalloïdes et des métaux, présents dans le corps de la plante en proportions infimes, peuvent cependant être des éléments physiologiques, aussi nécessaires au métabolisme général que le carbone et l'azote.*

Ces métalloïdes et ces métaux, trop peu abondants pour entrer dans la composition des appareils de soutien ou des substances de réserve, ne peuvent avoir, comme le manganèse, qu'on rôle d'intermédiaire, de catalysateur, dans les réactions chimiques. Il faut qu'ils entrent et sortent sans cesse des cycles de transformations utilisés par la cellule dans l'organisation des éléments plastiques. Leur rôle est, jusqu'à un certain point, comparable à celui des ferments et on peut les appeler, autant pour faire image que par commodité, *des infiniment petits chimiques.*

Nous sommes, dès lors, en droit d'aborder les conséquences qui se dégagent de cette importante conclusion. Limité par le temps, guidé par la nature de notre congrès, je m'attacherai seulement ici à l'une d'elles: c'est l'application du manganèse, du bore et d'autres infiniment petits chimiques à l'Agriculture.

J'ai déjà parlé de cette application au V^e Congrès international de Chimie, tenu à Berlin en 1903. A cette époque, la question était tout à fait dans l'enfance; depuis, elle a grandi quelque peu, des expériences nombreuses ont été faites, en différents pays, par beaucoup de savants et d'agronomes. La comparaison des résultats obtenus est intéressante et l'on peut sérieusement prétendre qu'en bien des cas, l'adjonction du manganèse, du bore et d'autres engrais, dits catalytiques, aux engrais ordinaires est d'une grande importance économique.

On n'a pas manqué, au début, d'objecter contre l'emploi agricole du manganèse, que la terre renfermait habituellement des quantités si grandes du métal qu'une faible addition devait rester sans effet.

A cette objection, je puis répondre tout d'abord que la quantité totale de manganèse trouvée dans le sol ne doit pas entrer seule en ligne de compte; une grande partie, sinon la totalité du métal peut exister sous des formes: silicates, sesquioxide, etc., difficilement solubles et inassimilables. L'adjonction d'un faible poids de sulfate ou même de carbonate de manganèse suffit alors à augmenter, dans une proportion relativement considérable, le stock de métal soluble nécessaire au développement de la plante.

Ensuite, comme le montre l'expérience du tableau II, la plante n'utilise pas la totalité du manganèse disponible. Elle en absorbe seulement une certaine proportion, d'autant plus petite que le stock est plus grand. Il est donc bon de lui en offrir beaucoup plus qu'elle n'en peut prendre.

L'expérience agricole est pleinement d'accord avec cette manière de voir. Il ne m'est pas possible, comme vous le comprenez, de vous donner un compte rendu d'étaibli des expériences extrémement nombreuses que j'ai faites ou qui sont parvenues à ma connaissance depuis plus d'une dizaine d'années. La suivante, consignée dans le tableau III, est parmi les plus typiques. Elle a été répétée à plusieurs reprises avec le même succès et elle vous donnera une très bonne idée de ce que l'on peut obtenir en opérant dans des conditions précises.

En comparant les chiffres placés sous vos yeux, vous voyez qu'une addition de sulfate de manganèse, correspondant à 15 kilog. environ de métal par hectare, a fourni une augmentation de 450 kilogrammes de grains et de 1000 kilogrammes de paille, sans compter un poids notable de racines qui est resté dans le sol et s'y est plus tard transformé en humus.

Ce résultat n'est pas le moins bon mais il n'est pas non plus le meilleur. A coté d'autres rare faibles ou même nuls, on a signalé des augmentations de récolte s'élevant jusqu'a 40%. De telles variations dépendent, comme dans le cas des engrais ordinaires, des espéces végétales cultivées et surtout de la nature du sol. Je ne puis entré ici dans le détail, mais, en résumant, je vous dirai que l'on a obtenu des résultats favorables dans les deux tiers environ des expériences entreprises.

On n'a pas seulement appliqué le manganèse comme engrais catalytique. Dans mon laboratoire, Javillier, Agulhon, dont je vous ai déjà cité les recherches, ont étudié, au même point de vue, le zinc et le bore. En Bohême, Stoklasa a essayé l'aluminium; au Japon, Loew et ses élèves: Aso, Nagaoka, Sawa, Katayama, en France, Boulanger, ont même fait des expériences avec le fluor, le baryum, le cérium, etc. De la série de ces résultats, il semble que le bore, et peut-être l'aluminium, puissent se ranger pratiquement à côté du manganèse.

Voici, tirée parmi beaucoup d'autres, une expérience d'Agulhon avec le bore et le maïs (Tableau IV) ainsi qu'une des expériences de Stoklasa avec l'aluminium et la betterave (tableau V).

TABLEAU IV

Influence du Bore sur la Culture du Maïs
(Agulhon)

Surface de chaque parcelle: 2 mètres carrés et demi.
Nature du sol: terre de jardin en jachère depuis plusieurs années.
Nombre des pieds par parcelle: 24.
Engrais ajouté: à la parcelle N° 1, rien,
à la parcelle N° 2, 28 kilog., soit 5 kilog. de bore, par hectare,
à la parcelle N° 3, 56 kilog., soit 10 kilog. de bore, par hectare.
Recolte en fourrage après 7 semaines.

Poids frais	3 kg. 835	5 kg. 985	6 kg. 190
Augmentations de poids frais		56%	61%
Poids secs	445 gr.	670 gr.	620 gr.
Augmentations de poids sec		50%	39%

Composition:

Eau	88,2%	88,9%	90,0%
Matières sèches	11,8%	11,1%	10,0%
Cendres % de mat. sèches	13,6%	13,0%	15,7%
Bore % de cendres	0,0241	0,0241	0,0274
— % de mat. sèches	0,0033	0,0032	0,0042

TABLEAU V

Influence de l'Aluminium sur la Culture de la Betterave (Stoklasa)

Surface de chaque parcelle: 5,000 mètres carrés.

Engrais ajoutés par hectare: I°, à chaque parcelle, 50 kg. de P^2O^5, à l'état de superphosphate; 60 kg. d'azote, à l'état de nitrate de sodium; 80 kg. de K^2O, à l'état de chlorure de potassium.

2°, en outre, aux parcelles en expérience 9 kg. d'aluminium, à l'état de sulfate.

Poids d'aluminium à l'hect.	0	9kg.
— des racines — —	35.800	36.100
Augmentations		300
Poids des feuilles	27.400	27.500
Sucre % de racine	17,3	17,5
— total à l'hect.	6.193	6.317
Augm. de sucre à l'hect.		124
— — — % de témoin		2,0

Poids d'aluminium à l'hect.	0	9kg.
— des racines — —	36.200	38.000
Augmentations		1.800
Poids des feuilles	18.400	20.800
Sucre % de racine	16,5	16,7
— total à l'hect.	5.973	6.346
Augm. de sucre à l'hect.		373
— — — % de témoin		6,2

Il ne faut pas oublier, lorsqu'on expérimente les engrais catalytiques, d'opérer avec un peu de prudence, car ils ont une grande activité physiologique. Si on en ajoute trop, on peut obtenir, comme cela s'est vu plusieurs fois, de mauvais résultats. Un tel effet, déjà sensible avec le bore, peut même devenir rapidement dangereux avec le zinc. Il varie d'ailleurs beaucoup avec les espèces, végétales et l'on peut voir, dans un même sol, le maïs résister beaucoup plus que l'avoine à l'élévation excessive de la dose d'acide borique.

La connaissance du rôle des infiniment petits chimiques, même envisagée au seul point de vue agricole, touche à plusieurs problèmes. Il touche tout d'abord à celui des causes de la fertilité des sols. Pour apprécier la valeur de ceux-ci il va falloir tenir compte, non-seulement de leur richesse en azote, en phosphore et en potassium, mais aussi en d'autres métalloides et métaux et nous allons ainsi être conduits à l'adoption de méthodes d'analyse dont nous n'avons pas encore l'habitude.

La connaissance du rôle des infiniment petits chimiques nous apporte un nouvel argument explicatif de la nécessité des rotations culturales. Lorsque certaines plantes sont maintenues sans discontinuité sur le même sol, il arrive souvent que le poids des récoltes diminue très vite avec les années pour devenir parfois presque nul et, celà, malgré des additions régulières de fumier et d'engrais chimiques destinées à compenser les pertes d'humus, d'azote, de potassium et de phosphore. Au contraire, si on établit des rotations c'est-à-dire si on fait alterner la culture de ces plantes avec celles déspèces végétales très différentes, par exemple, la betterave avec l'avoine et la luzerne, on obtient chaque fois des récoltes normales.

La tendance est très forte aujourd'hui d'expliquer ce phénomène par un empoisonnement du sol par les racines. Selon cette explication, chaque espèce produirait des substances toxiques particulières, comparables à l'urine et aux gaz de la respiration humaine, substances dans lesquelles la plante production ne pourrait plus continuer à vivre. Ces substances, non toxiques pour une autre espèce, disparaitraient, par oxydation ou autrement, dans l'intervalle de la rotation. N'est-il pas aussi probable d'admettre qu'une plante peut cesser de croître dans un sol lorsqu'elle a abaissé, au-dessous d'une certaine proportion, la partie assimilable d'un élément catalytique dont elle a un besoin particulier. En admettant cette explication, il resterait encore assez de l'élément considéré sous la forme assimilable pour une autre espèce moins exigeante et la provision primitive pourrait alors se renouveler pendant la rotation, grâce aux influences atmosphériques et aux actions microbiennes.

L'examen comparé de ces théories n'a pas seulement un intérêt spéculatif; il a aussi une valeur pratique. En effet, si la seconde théorie est la bonne, il devra suffir de déterminer la nature et la proportion de l'élément ou des éléments catalytiques spéciaux à chaque culture, puis de les ajouter au sol, pour rendre à celui-ci toute sa fertilité et se délivrer, si on y trouve profit, de la nécessité des rotations culturales.

Il est intéressant de remarquer que, lorsqu'on ajoute une substance fertilisante au sol, on n'agit pas uniquement sur la plante dont on veut augmenter la récolte. On modifie encore, dans un sens ou dans l'autre, la nutrition des espèces microbiennes, des champignons et de tous les êtres microscopiques qui vivent dans le sol. Il n'est pas impossible qu'en ajoutant du manganèse par exemple, on favorise sélectivement certains microbes oxydants capables de former des nitrates ou de détruire les toxines dont je vous parlais tout à l'heure. Il faut sans doute rechercher, dans la richesse relative des sols en certains éléments catalytiques, les causes de l'adaptation des espèces végétales, les raisons de la facilité plus ou moins grande que possèdent les sols de nourrir telle plante et non pas telle autre.

Enfin, la notion des infiniment petits chimiques peut-être introduite jusque dans l'étude de la Pathologie végétale. L'*Aspergillus niger* et les moisissures utilisent des doses de zinc beaucoup plus élevées que les plantes supérieures. Or, il a paru, dans les recherches de Javillier, que le froment, l'avoine, etc., cultivés dans des milieux additionnés de zinc et qui, sans doute, en avaient absorbé une proposition superieure à la normale, étaient plus facilement atteints par l'*Erœsyphe* que les mêmes plantes venues dans les milieux témoins où il ne pouvait y avoir que des traces du métal. Ainsi, qu'il s'agisse de parasitisme ou de occupation du sol, le conflit des espèces reste sous la dépendance de la composition chimique. Et notre esprit entrevoit comment des variations dans le rapport de certains éléments dont la présence exige les méthodes les plus délicates de la physique et de la chimie pour être démontrée, peuvent entrainer, selon les cas, la prospérité ou la maladie et la mort.

L'Agriculture est la branche de l'activité humaine qui augmente le plus le capital d'énergie mondiale. En s'efforçant d'obtenir des récoltes abondant de céréales, de textiles, de sucre, de fourrage, etc., elle favorise la captation d'une énergie qui est étrangère au globe terrestre et qui ne coute rien, l'énergie solaire, origine de toutes les autres formes d'énergie utilisées par l'homme.

Perfectionner l'Agriculture, forcer le sol au maximum de rendement, c'est donc abaisser le prix des aliments, augmenter les forces humaines, faciliter l'asservissement de la matière et la libération de l'intelligence.

Dans un pays où cette grande question a été si bien comprise, il m'était particulièrement agréable d'évoquer, à l'occasion du Congrès qui vient de s'ouvrir, une application de la Chimie biologique à l'Agriculture. Je souhaite que la notion du rôle des infiniment petits chimiques chez les plantes que je viens de vous présenter, fasse faire à l'Agriculture quelques progrès.

Sir William Ramsay, in moving a vote of thanks to M. Bertrand alluded to the fact that Liebig, many years ago, had shown what the grass food of plants should be; and the world, by the use of artificial manures had profited by his advice. To put the matter familiarly, the beef, mutton, potatoes, and corn had been provided for plants. But none of us likes food without condiments; and indeed, M. Armand Gantier, the eminent compatriot of M. Bertrand, had shown in reference to the terrible disease myxodama that the animal organism must be supplied with small traces of iodine and arsenic, else it suffers in health. M. Bertrand explained, in his lecture, how condiments containing mere traces of certain elements which must be regarded as stimulants rather than as foods were necessary for the healthy life of some plants, and pointed the way for improvements in agriculture which cannot fail to be of the utmost benefit to plant culture, and to the welfare of mankind.

Professor Charles A. Doremus in seconding Sir William Ramsay's motion said:

"As a graduate of this College and a former member of its

staff it gives me intense pleasure to see you here. This fine and spacious Hall was designed, in part, that the City might invite assemblages like this Congress to meet within its walls. Such occasions are inspiring to the community.

"The unexpected is still happening and we learn from the distinguished lecturer, Professor Bertrand, of the influence of traces of the chemical elements on the growth of plants. We hope that before long he will disclose some subtle influence promoting not only the healthful growth of the human body but also our intellectual development.

"It gives me great pleasure to second Sir William Ramsay's vote of thanks."

The motion was carried unanimously amid great applause.

General Lecture of Monday, September 9, 1912

Program of Organ Recital

Mr. Mark Andrews, *Organist*

1	Vision	*Rheinberger*
2	Toccata and Fugue in D minor	*J. S. Bach*
3	Canzonetta	*Mendelssohn*
4	Choral and Variations (Sixth Sonata)	*Mendelssohn*
5	Evening Star Song	*Wagner*
6	Liebestod	
7	Ride of the Valkyries	

Address of Carl Duisberg, Elberfeld

FORTSCHRITTE UND PROBLEME DER CHEMISCHEN INDUSTRIE

Wohl auf keinem Gebiete menschlichen Könnens und Wissens sind durch die Verbindung von Wissenschaft und Technik und die dadurch bedingten wechselseitigen Beziehungen so bedeutende Fortschritte erzielt worden, wie auf dem der chemischen Industrie, die zwar in ihren Anfängen alt, in ihrer grosszügigen Ausgestaltung aber ein Kind der neuesten Zeit ist und sich in allen Kulturstaaten mehr oder weniger kräftig entwickelt hat. Die Erfolge haben diese Industrie so kühn gemacht, dass sie sich zur Lösung jedes Problems fähig hält, wenn ihr nur tüchtige, wissenschaftlich und technisch geschulte Männer zur Verfügung stehen, die sich unter Einsetzung ihrer ganzen Kraft mit Ausdauer und Geduld der gestellten Aufgabe zuwenden. Das haben wir gesehen—bei der Schwefelsäure im Kampf des neuen Kontaktprozesses gegen das alte Kammerverfahren,—bei der Soda in dem Ringen des Solvay-Prozesses mit dem von Leblanc, —bei der Salpetersäure und ihren Salzen durch direkte Oxydation des Stickstoffs der Luft mit Hülfe der Hitze des elektrischen Flammenbogens,—beim Ammoniak ebenfalls aus dem Stickstoff der Luft, auf indirektem Wege über den Kalkstickstoff, auf direktem Wege durch seine Vereinigung mit Wasserstoff,—beim Ersatz des Krapps durch das künstliche Alizarin,—des natürlichen Indigos durch den künstlichen Indigo—und bei zahlreichen anderen Prozessen der Farbstoff - der Riechstoff - und der pharmazeutischen Industrie.

Wenn ich es heute unternehme, in der kurzen Frist von einer Stunde und vor einem Publikum, das nicht nur aus Fachgenossen, sondern auch aus Laien besteht, über die neuesten Fortschritte zu berichten, die wir in der chemischen Industrie erzielt haben, und von den Problemen zu erzählen, die uns gegenwärtig beschäftigen, so müssen wir uns weitgehendste Beschränkung auferlegen, sowohl in der Auswahl des Stoffes wie in der Art der Behandlung. Wir können dabei nur eine Auslese aus den wichtigsten Kapiteln unserer Industrie halten und müssen von vornherein auf eine Vertiefung in chemischer oder technischer Richtung Verzicht leisten. Was wir aber, wegen mangelnder Zeit, nicht sagen können, das soll das hier aufgestellte reiche Demonstrationsmaterial an Tafeln, Produkten and Stoffen aller Art erläutern. Was sich wiederum weder sagen, noch in dieser Weise demonstrieren lässt, das mögen Ihnen einige Lichtbilder zeigen. Haben Sie die nötige Geduld, so führe ich Ihnen zum Schlusse eine der neuesten Fabrikationsstätten der deutschen chemischen Industrie am Rhein mit allen ihren technischen und besonders auch sozialen Einrichtungen vor.

So lade ich Sie mit dem Motto aus dem Faust: "Wer vieles bringt wird manchem etwas bringen," ein, mit mir gleichsam in einem Luftschiff über die Gefilde der chemischen Industrie hinweg zu fliegen und aus der Vogelperspektive auf ihre neuesten Leistungen herab zu schauen. Dabei wollen wir in Schleifenfahrten bald das eine, bald das andere Gebiet, das unser Interesse am meisten in Anspruch nimmt, etwas näher betrachten.

KRAFTERZEUGUNG

Die wichtigste Frage für jede Industrie, die Krafterzeugung, die besonders bei der Synthese der Salpetersäure und des Ammoniaks von ausschlaggebender Bedeutung ist, wird jetzt von der vervollkommensten Wasserbaukunst und der Entwickelung der

Turbinen beherrscht. Die elektrische Kraftübertragung macht nicht nur die Wasserkräfte in weiteren Bezirken nutzbar, sondern gestattet auch, statt des Brennmaterialtransportes die am Ort der Kohlen- oder Torf-Lager erzeugte Energie auf bestimmte Entfernungen hin fortzuführen. Erst seit kurzem haben wir die Prinzipien der Wasserturbine auf die Dampfturbine übertragen gelernt. Aber der Fortschritt in der Energieausnutzung, den uns diese veränderte Konstruktion gegenüber der von *Watt* vor ca. 150 Jahren sinnreich erdachten Kolbenmaschine gab, wird schon wieder übertroffen von Benzin-, Petroleum- oder Oel-Motoren und vor allem von den sicher arbeitenden Grossgasmaschinen, die durch Hochofengas, Mondgas oder neuerdings auch Torfgas getrieben werden.

NEBENPRODUKTEGEWINNUNG

Hand in Hand mit dieser direkteren Ausnutzung der Energie des Brennmaterials geht die Gewinnung von Nebenprodukten, des für die Landwirtschaft so wichtigen Ammonsulfats und der anderen für die Farbenindustrie so nötigen Destillationsprodukte. Die neueste und rationellste Nutzbarmachung der Torfmoore (an denen nicht nur Deutschland, sondern auch zahlreiche andere Länder reich sind) wird nach dem Verfahren von *Frank-Caro* durch Erzeugung und Verwertung von Torfgas mit Ammoniakgewinnung in einer 3,000 pferdigen elektrischen Kraftzentrale in dem Schweger Moor bei Osnabrück unter Nutzbarmachung der abgeräumten Moorflächen für Besiedelung und Bebauung betrieben.[1]

Das grösste Problem der Energietechnik, die direkte Ueberführung der Kohlenenergie in elektrische Kraft mit Hilfe der *Gasbatterie*, dessen Lösung man vor 25 Jahren schon erhofft hatte, ist auch heute noch ein Traum geblieben.

[1] Aus 1,000 kg absolut wasserfreiem Torf, in Form von luftgetrocknetem Torf mit einem Feuchtigkeitsgehalt von 45 bis 60 und 70%, werden hier 2,500 bis 2,600 cbm Gas mit 1,100 bis 1,300 Wärmeeinheiten erhalten. Diese liefern eine nutzbare Kraftausbeute von 1,000 PS Stunden = 700 Kilowattstunden, nach Abzug sämtlichen Eigenbedarfs der Gasanlage an Kraft und Wärme, sowie eine Salzausbeute von 35 kg Ammonsulfat bei einem Stickstoffgehalt des Torfmoors von 1%.

KÄLTEERZEUGUNG

Neben der Erzeugung von Kraft und Wärme spielt die Kälteerzeugung in der chemischen Industrie eine immer grössere Rolle. Statt der Ammoniakmaschinen mit ihrer Temperatur von minus 20° stehen uns heute Schwefligsäuremaschinen und besonders Kohlensäurevergaser zur Verfügung, die auf minus 40° arbeiten. Kältemaschinen unter Verwendung von geeigneten Kohlenwasserstoffen, die die Temperatur bis minus 80° herabzudrücken vermögen, sind in Sicht. Die Anlagen zur Luftverflüssigung mit ihren ganz tiefen Graden von minus 190° C verbreiten sich mehr und mehr und sind besonders da rentabel, wo man die gleichzeitig erzeugten sauerstoffreichen Gemische oder den reinen Stickstoff benötigt. Eine schematische Darstellung des von Linde erfundenen Verfahrens der Rektifikation flüssiger Luft behufs Zerlegung in Stickstoff und Sauerstoff sehen Sie auf jenem Tableau. Dass die *Badische Anilin-und Soda-Fabrik in Ludwigshafen a. Rh.* die Absicht hat, auf diese Weise auch aus dem Wassergas den Wasserstoff zu gewinnen, unter gleichzeitiger Verwertung des Kohlenoxyds für Kraftzwecke, um dann mit dem durch Verflüssigung der Luft und Rektifikation gewonnenen reinen Stickstoff das *Habersche* Verfahren der Ammoniaksynthese in einer grossen, im Bau befindlichen Anlage durchzuführen, wird an anderer Stelle während dieses Kongresses durch den Direktor dieser Fabrik, Herrn Professor Dr. *Bernthsen*, vorgetragen werden.

GRÖSSE DER APPARATE

Nach dem berühmten Vorbilde der *Solvay*-Sodafabrikation und den dadurch erzielten kalkulatorischen Vorteilen haben sich allgemein die Apparaturen in der chemischen Industrie enorm vergrössert. Gerade hierin ist Nordamerika, sicherlich veranlasst durch seine Eisenindustrie, mit den Hochöfen von 500 tons Tagesproduktion, den riesigen Transportmitteln (50 tons Wagen) und den gewaltigen Hebewerkzeugen am weitesten gegangen. Aber schon zeigt sich hier für die genau kalkulierende Technik eine Grenze. Bekannt ist der Misserfolg des allzu grossen *Mactearofens* für *Sulfat* mit einer Tagesproduktion von 25 tons, während der mechanische Sulfatofen des *Vereins chemischer Fabriken in Mannheim*, der nur 7 tons täglich leistet, überall Eingang findet. Vielleicht werden die hohen Herstellungskosten und die bei der Betriebsstörung ausfallenden grossen Einheiten das Mass des in Amerika entstandenen, bewunderswerten *Wedgeofens*, mit einer Tagesverarbeitung von 30 tons Schwefelkies wieder zu reduzieren zwingen.

Auch in der organisch-chemischen Industrie haben sich die eisernen Gefässe, in denen man chloriert, sulfiert, nitriert, reduziert und ozydiert, sowie die hölzernen Bottiche, in denen man diazotiert und Farbstoffe herstellt, von den kleinen Kesseln und Bütten der früheren Jahre zu gewaltigen Grössen entwickelt. Sie finden meist ihre Grenze in der Leistungsfähigkeit der mechanischen Industrie. Doch die oft sich einschleichenden Fehler bei der Fabrikation mit ihren Rückschlägen in der Kalkulation mahnen zu weisem Masshalten.

Wo immer es durchführbar ist, sind an Stelle der diskontinuierlichen Prozesse mit ihren zeitraubenden und geldkostenden Pausen der Abkühlung und Anwärmung die ununterbrochen arbeitenden Verfahren getreten. So hat das Verfahren von *Uebel* mit übereinander liegenden Retorten ohne Rührwerk bezw. dasjenige der *Badischen Anilin- und Soda-Fabrik* mit hintereinander geschalteten Arbeitsräumen und Rührwerk behufs Darstellung von *Salpetersäure* aus Chilesalpeter das alte Einzelretortenverfahren verdrängt.

MATERIAL

Für das Material der chemischen Apparate kommen verschiedene neue Fabrikate in Betracht.

QUARZGEFÄSSE

Abgesehen davon, dass die nordische Salpeterindustrie gelehrt hat, ihre dünnen nitrosen Gase in 20 Meter hohen Türmen aus bis dahin chemischen Zwecken selten dienstbar gemachtem Granit zu absorbieren, stehen uns heute säure- und hitzebeständige Rohre, Schalen und Gefässe aus gesinterter Quarzmasse, die in fast denselben Grössen wie die bekannten Tongegenstände zu haben sind, zur Verfügung.

EDELSTAHLE

Die grössten Fortschritte jedoch sind auf dem Gebiete der Eisenlegierungen oder des Edelstahls gemacht worden.

Dank der Liebenswürdigkeit der Firma *Fried. Krupp in Essen* bin ich in der glücklichen Lage, Ihnen auf diesem Gebiete eine grosse Zahl bisher unbekannter und für den Chemiker wichtiger Neuerungen mitzuteilen, und an hier ausgestellten prachtvollen Präparaten und Photographien sowie durch Lichtbilder ad oculos zu demonstrieren. Ich muss Sie aber bitten, jetzt die obenerwähnte Schleifenfahrt mit mir zu machen, damit ich etwas ausführlicher sein kann. Sie werden staunen über die grossen Fortschritte, die hier vor allem auch zum Nutzen unserer Industrie erzielt worden sind.

Bei den Eisenlegierungen handelt es sich hauptsächlich darum, an die Stelle des Kohlenstoffs andere Elemente zu setzen, die ebenso wie dieser, die Festigkeit erhöhen, aber die Entstehung eines krystallinischen, leicht spaltbaren Gefüges verhindern. Unter diesen Elementen steht in erster Linie das Nickel.

NICKELSTAHL

Die Legierungsfähigkeit des Nickels mit Eisen ist eine altbekannte Sache. Schon zur Zeit Bessemers hatte man in Grossbritannien versucht, Geschütze aus Stahl mit 2% Nickel zu fertigen. Die Versuche misslangen, da das Nickel der damaligen Zeit nicht rein, sondern durch Kupfer, Arsen und Schwefel verunreinigt war. Deshalb liessen sich die Eisenlegierungen daraus nicht schmieden. Erst das *reine* Nickel, wie es uns heute zur Verfügung steht, führte 30 Jahre später zu durchschlagenden Erfolgen.

Aehnliche Wirkungen wie durch Nickel erzielte man, und zwar auch erst, nachdem es gelungen war, *Chrom, Silicium* und *Mangan* frei von Verunreinigungen darzustellen, durch Legierung des Eisens mit diesen Elementen entweder allein oder in Verbindung mit Nickel.

Die Hauptaufgabe bei allen Stahllegierungen ist die Bildung eines amorphen, sehnigen Gefüges. Dies erreicht man nicht nur durch Verdrängung des Kohlenstoffs in mehr oder weniger grossen Mengen, sondern vor allem auch durch bestimmte *thermische Behandlungen,* indem man die Stahlerzeugnisse aus hohen Temperaturen plötzlich abkühlt und dann wieder erwärmt und auf bestimmte niedere Temperaturen hält.

So sehen Sie hier bei Stahlproben und dort im Bild bei 200 facher Vergrösserung einmal die grobe Krystallisation des reinen Kohlenstoffstahls in ungeschmiedetem Zustande und das anderemal die durch thermische Behandlung erzielte Verfeinerung desselben. Auch ist der Unterschied im Gefügeaufbau des geschmiedeten Kohlenstoffstahls und des geschmiedeten und thermisch behandelten Nickelstahls zu beobachten. Während der Kohlenstoffstahl auch im geschmiedeten Zustande immer noch krystallinische Struktur mit sichtbaren Spaltflächen der Krystalle aufweist, zeigt der Nickelstahlbruch ein dem Schweisseisen sehr ähnliches amorphes Gefüge,—zum Vergleich ist ein Schweisseisenbruch beigefügt—wobei nicht unerwähnt bleiben soll, dass die Nickel-und Chromnickelstahle in der Festigkeit das Schweisseisen um das 2 bis 3 fache übertreffen. Weiter sind einige stark deformierte Konstruktionselemente aus legiertem Stahl für den Automobilbau ausgestellt. Trotz der hohen Festigkeit von ca. 90 kg pro Quadratmillimeter ist kein Bruch eingetreten.

Abgesehen von diesen den Konstruktionsstählen zugute kommenden Verbesserungen haben sich diese Legierungen des Eisens noch eine ganze Reihe neuer Verwendungsgebiete erschlossen.

Wir erwähnen nur kurz die für den Schiffbau, die Elektrotechnik, sowie für Ventile und Ventilspindeln wichtigen Legierungen des Stahls mit viel Nickel, und zwar von 23% und darüber, die unmagnetisch und widerstandsfähig gegen die Einflüsse der Atmosphärilien sind, die 30% Nickel enthaltenden Stähle, die sich durch hohen elektrischen Widerstand auszeichnen, die 45% Nickelstähle, deren Ausdehnungscoefficient 1/20 desjenigen des gewöhnlichen Stahls beträgt und, was für die Optik wichtig ist, nicht grösser als derjenige des Glases ist.

CHROM-, WOLFRAM- UND MOLYBDÄNSTÄHLE

Neu und besonders für uns Chemiker interessant ist, dass man den billigeren, unlegierten Flusseisenblechen und Profileisen eine erhöhte, dreimal so grosse Widerstandsfähigkeit gegen die zerstörenden Einwirkungen der Säuren geben kann, wenn man die Struktur ausschliesslich mittelst thermischer Behandlung beeinflusst. Nimmt man Legierungen des Eisens mit Chrom, Wolfram, Molybdän und Aluminium in bestimmten Verhältnissen und behandelt sie dann thermisch, so steigt die Widerstandsfähigkeit gegen Säuren auf das 5 fache, wie dies die dort ausgestellten Proben von gewalztem Kohlenstoff- und Chromnickelstahl deutlich zeigen, die 56 Tage mit verdünnter Schwefelsäure gebeizt wurden.

Als vorzügliches Material, das heisser Natronlauge zu widerstehen vermag, hat sich 5% iges *Nickelflusseisen* erwiesen.

Ueberraschende Eigenschaften zeigen Stahllegierungen mit *sehr hohem Chromgehalt* mit mehr als 10%, und geringem Molybdänzusatz, 2–5%, wie sie nach den Patenten von Borchers und Monnartz in Aachen von der Firma *Fried. Krupp* in Form von bearbeitbaren Guss- und Schmiedestücken hergestellt und von den *Mannesmannröhrenwerken* in Remscheid zu Röhren ausgewalzt werden. Diese Legierungen, wenn sie 60% Chrom, 35% Eisen and 2 bis 3% Molybdän enthalten, sind nicht nur in verdünnter Salz- und Schwefelsäure, sondern auch in verdünnter Salpetersäure, selbst wenn ihr Alkalichlorid zugefügt wird, unlöslich, *ja sie widerstehen sogar siedendem Königswasser.* Sie sehen dort der Säurewirkung ausgesetzte Proben dieses merkwürdigen Stahls im Vergleich zu Gusseisen und gewöhnlichem Stahl.

WERKZEUGSTÄHLE

Dass diese Legierungen des Eisens mit den Metallen Chrom, Wolfram und Molybdän als Werkzeugstähle in Form der von den Amerikanern *Taylor und White* mit Hilfe eines eigenartigen Härteverfahrens erzeugten Schnelldrehstähle von grösster Wichtigkeit sind, sei besonders hervorgehoben.

VANADINSTAHL

Die neuesten Fortschritte auf diesem Gebiete, das sich der wachsenden Festigkeit der Konstruktionsstähle anpassen muss, sind unter Verwendung des mehr und mehr Anwendung findenden Vanadiums gemacht worden. Dieses Metall ist leider noch sehr teuer, und es gehört zu den Problemen, die dem Chemiker zu lösen obliegen, es billiger zu machen. Gelingt es, den Preis wesentlich herunter zu bringen, so wird ihm von den Metallurgen eine grosse Zukunft prophezeit, da die Einwirkung des Vanadiums auf das Gefüge eine unverkennbare ist.

Wichtig sind aber auch die Legierungen des Eisens mit Chrom, Wolfram und Vanadium, welche bei hohen Temperaturen von 400 bis 500°C noch eine grosse Festigkeit besitzen. Sie werden von den Ingenieuren benötigt beim Dampfturbinenbau und bei dem in neuerer Zeit so beliebten Prägen oder Spritzen von Metallgegenständen in rotglühendem Zustande, von den Chemikern überall da, wo chemische Reaktionen bei hoher Temperatur und hohem Druck zu vollziehen sind, wie z. B. bei der synthetischen Darstellung des Ammoniaks nach Haber.

Ganz neu und von grossem Wert ist eine für den Tresor- und Geldschrankbau bestimmte, unter Patentschutz gestellte Stahllegierung der Firma Fried. Krupp. Sie ist nicht nur undurchbohrbar und unzertrümmerbar, sondern wird auch von autogenen Schneidbrennern nicht durchschmolzen.

Sie sehen hiervon 2 Proben, und zwar gewöhnlichen Stahl, in den in 5½ Minuten mit Knallgas und in 6 Minuten mit dem Acetylensauerstoffgebläse grosse Löcher geschmolzen sind, und eine andere aus diesem neuen legierten Stahl, bei dem dieselbe Sauerstoff-, Wasserstoff-bezw. Acetylen-Flamme 1½ Stunden lang ohne wesentliche Einwirkung geblieben ist.

An diesem harten und unschmelzbaren Tresorstahl werden sich hoffentlich die Geldschrankknacker ihre Zähne vergeblich ausbeissen.

MANGANSTAHL

Von den Legierungen des Eisens mit dem Mangan kommt hauptsächlich der von *Robert Hadfield* zuerst dargestellte Mangan- oder Hartstahl, in Form von gegen Verschleiss äusserst widerstandsfähigen Gusstücken für den Zerkleinerungsmaschinenbau und für den Geleisebau bei elektrischen Strassenbahnen zur Anwendung. Infolge seiner grossen Härte ist dieser Stahl nicht bearbeitbar, aber trotzdem in kaltem Zustand deformierbar und dadurch sehr gesichert gegen Brüche. Er hat deshalb auch für alle Zweige der chemischen Industrie, wo, wie fast überall, Mahlwerke benötigt werden, grösstes Interesse.

SILICIUMSTAHL

Endlich seien noch die Legierungen des Eisens mit dem Mangan und Silicium erwähnt, die bei einem Gehalt von 1½ bis 2½% Silicium und einem höheren Kohlenstoffgehalt vorzügliche Werkzeugstähle und Stahl für hoch beanspruchte Federn liefern. Diese Eisenlegierungen mit viel Silicium haben sich als sehr widerstandsfähig gegen Säuren erwiesen und kommen neuerdings für diesen Zweck mehr und mehr in Aufnahme, obgleich sie leicht porös und überaus spröde sind.

Wichtiger ist die *ganz kohlenstoffarme* Siliciumlegierung mit etwa 4% Silicium. Zu ihr hat ebenfalls *Robert Hadfield* die erste Anregung gegeben, während die Firma *Krupp* in Verbindung mit *Capito* und *Klein,* einem rheinischen Feinblechwalzwerk, dieses Material wesentlich verbessert und der Elektrotechnik zugeführt haben, wo es in Form von 0.35 Millimeter dicken Blechen in grossen Massen—der jährliche Verbrauch in Deutschland allein beziffert sich gegenwärtig schon auf 8,000 tons—beim Bau von Dynamos, Wechselstrommotoren und Transformatoren verwendet wird. Dieses Material hat nämlich nur einen halb so grossen Wattverlust wie gewöhnliches Eisen, bei einem 4 bis 5 mal so hohen elektrischen Widerstand, wodurch die schädlichen Wirbelströme auf ein Minimum herabgedrückt werden. Dadurch ist der Bau von Transformatoren erheblich verbilligt worden, da das Verhältnis von Eisen und Kupfer ein wesentlich günstigeres ist. Die Herstellung dieser *kohlenstoffarmen Siliciumeisenlegierungen* ebenso wie diejenigen der ganz kohlenstoffarmen Chromnickelstähle war erst möglich, nachdem Silicium und Chrom mittelst elektrischen Schmelzverfahren kohlenstoffrei hergestellt werden konnten.

ELEKTROSTAHL

Seitdem man den elektrischen Schmelzofen direkt in den Dienst der Stahlfabrikation gestellt hat, ist endlich auch die von chemischen Gesichtspunkten aus wichtige, lange vergeblich versuchte Lösung des Entschwefelungsproblems von Erfolg gekrönt worden. Man hat gefunden, dass der Elektrodenofen eine vollständig metallfreie Schlacke zu erzeugen imstande ist, und dass man diese als Vorbedingung zur praktisch völligen Entschwefelung des Stahlbades ansehen muss.

ELEKTROLYTEISEN

Dem kohlenarmen Siliciumstahl in seinen elektrischen Eigenschaften überlegen ist das von *Franz Fischer* in Charlottenburg hergestellte Idealmetall für Elektromagnete, das reine *Elektrolyteisen*, das von den *Langbein-Pfanhauser Werken* in Leipzig, fabrikmässig erzeugt wird. Man konnte es früher nicht frei von Wasserstoff machen, weshalb es hart und spröde war, und sich nicht bearbeiten liess. Erst dadurch, dass man die Elektrolyse unter Anwendung einer mit hygroskopischen Salzen, wie Chlorcalcium, versetzten Eisensalzlösung bei Temperaturen von 100 bis 120° vollzieht, wird es wasserstoffrei. Seine Härte sinkt dann weit unter die des Silbers und Goldes, und ist nicht viel grösser als die des Aluminiums. Es besitzt die wertvolle Eigenschaft, schneller als gewöhnliches kohlenstoff-oder siliciumhaltiges Eisen magnetisch zu werden, aber auch wiederum schneller den Magnetismus zu verlieren. Dadurch wird die Leistungsfähigkeit der Elektromotoren um ein erhebliches gesteigert.

Gegenstände aus diesem Elektrolyteisen finden Sie dort, so eine in 5 tägigem ununterbrochenem Betriebe durch Einhängen eines Elektrolyteisenblechs hergestellte Kathode, daraus durch Walzen hergestellte Bleche und so einen Drehstrommotor. Letzterer aus siliciumhaltigem Eisen würde 0,5 PS leisten; durch Anwendung von Elektrolyteisen aber ist er bei mehrmonatlicher Dauerbelastung auf eine mehr als $2\frac{1}{2}$ fache Leistung, nämlich auf 1,3 PS gebracht worden, ohne Alterungserscheinungen zu zeigen.[1]

Mit diesen verschiedenartigen neuen Materialien, zu denen sich noch Kupfer mit 10% Silicium und Kupfernickel gesellen, werden sich sicherlich die dem Verschleiss so sehr unterworfenen chemischen Apparate wesentlich widerstandsfähiger und haltbarer als bisher machen lassen.

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[1] Näheres siehe Zeitschrift für Elektrochemie No. 16, 1909.

Nach diesem Ausfluge in's Gebiet der Metallurgie wollen wir uns jetzt der eigentlichen chemischen Industrie wieder zuwenden und mit der *anorganischen Grossindustrie* beginnen.

SCHWEFELSÄURE

Der Siegeslauf der Schwefelsäurefabrikation nach dem Kontaktverfahren in den Vereinigten Staaten hat in Deutschland kaum seinesgleichen. Noch immer ist Platin, trotz seines beinahe verdreifachten Preises, unser Hauptkontaktmaterial. Da es möglich ist, alle chemischen Kontaktprozesse mit verschiedenartigen Kontaktkörpern erfolgreich durchzuführen, so wird dieses sicherlich auch beim Schwefelsäureanhydrid der Fall sein. Einen billigen Ersatz für Platin zu suchen, ist daher eine dankbare Aufgabe. Allerdings ist es den Amerikanern gelungen, in den 20 Jahren, die seit der grossartigen Durchführung des Anhydridprozesses durch *Knietsch* verstrichen sind, die Leistung, berechnet auf das gleiche Gewicht Platin, zu verdreifachen. Dass trotzdem der alte Bleikammerprozess konkurrenzfähig blieb, ist ebenso anerkannt, wie seine Vervollkommung in Bezug auf Arbeitsweise und Säure-Reinheit. Dabei versprechen die neuesten Fortschritte auf diesem Gebiete, wie wir sie in *Faldings* hohen Kammern und *Opls* mit grossen Säuremengen berieselten Türmen vorfinden, weitere Erfolge.

In der Säurekonzentration bezw.-Wiedergewinnung steht der *Gaillardturm,* auch für Regenerierung der verschiedenen Abfallsäuren, an der Spitze.

AMMONSULFAT

Ein neuer Weg der Schwefelsäureherstellung, verbunden mit der Ammoniakgewinnung aus den Gasen, die bei der Trockendestillation der Kohle abziehen, zeigt sich am Horizont. *Burkheiser* sucht mit Hilfe von besonders präparierten nassen Eisenverbindungen den Schwefel unter gleichzeitiger Absorption des Cyans zu binden und das dann daraus erzeugte schwefligsaure Ammoniak durch Luftoxydation in Ammonsulfat überzuführen.

In Konkurrenz damit sucht *Walter Feld* durch eine Reihe interessanter chemischer Reaktionen, bei denen das Thiosulfat eine grosse Rolle spielt, den Schwefel direkt als Ammonsulfat zu gewinnen. Versuchsanlagen sind in Königsberg und auch hier in New York im Betrieb.

STICKSTOFFVERBINDUNGEN

Ueber die Fortschritte, die bei der Nutzbarmachung des Luftstickstoffs in den letzten 5 Jahren erzielt sind, ist schon so oft berichtet worden, dass ich weder auf das Verfahren von *Birkeland-Eyde, Schönherr* oder *Pauling* der direkten Oxydation des Stickstoffs im Flammbogen, noch auf die Darstellung von Kalkstickstoff und Cyanamiden von *Frank-Caro*[1], noch endlich auf das *Serpekverfahren* aus Aluminiumnitriden unter Verwertung der daneben erzeugten Tonerde Ammoniak zu machen, einzugehen brauche. Das Problem, konzentrierte Salpetersäure aus der dünnen Säure, wie sie bei der grossen Absorptionsapparatur der verdünnten Stickoxydgase erhalten wird, ist jetzt unter Anwendung von Schwefelsäure in Turmsystemen nach *Pauling* gelöst. Auch die glatte Ueberführung des Kalkstickstoffs in Ammoniak und die rationelle Umwandlung des letzteren in Salpetersäure lässt sich erfolgreich durchführen.

SODA UND CHLOR

Unbekämpft geblieben ist der 50 jährige weltbeherrschende *Solvay-Soda*-Prozess. Es ist dieses um so merkwürdiger, als er in chemischer Ausbeute noch immer unvollkommen dasteht, indem ein Viertel des verwendeten Steinsalzes als solches und dazu noch sämtliches Chlor in Form von Chlorcalcium verloren gehen. Trotz der theoretisch vollkommenen Ausnutzung aller Produkte beim *Leblanc*-Prozess ist diesem damit weder geholfen worden, noch bietet sich die Aussicht, dass dieses jemals wieder der Fall sein wird.

Nicht minder merkwürdig ist die 25 jährige Laufbahn der

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[1] Die Weltproduktion von Kalkstickstoff beträgt nach Mittheilungen des Herrn Dr. N. Caro z. Zeit 120,000 tons pro Jahr. Davon werden 32,000 t. in Deutschland (16,000 in Trostberg u. 15,000 t. in Knapsack bei Cöln) u. 19,000 tons von der American Cyanamide Company zu Niagarafalls erzeugt. In den nächsten drei Jahren soll aber die Gesamtproduktion auf 200,000 tons vergrössert werden.

Chlor-alkali-Electrolyse. Der beschränkte Chlormarkt und die grossen Raum verbrauchende Konstruktion der elektrolytischen Bäder haben den scheinbar so einfachen Prozess behindert. Auch die am meisten bewährten Verfahren, die *Griesheimer Zementzelle,* die *Quecksilberkathoden* von *Castner* und seinen Nachfolgern, die *Aussiger Glocke* und das *Drahtnetzdiaphragma* von *Hargreaves* mit seinen verschiedenen Abarten, wie es neuerdings in der *Townsendzelle* eine gute Lösung gefunden hat, konnte sich deshalb nicht in der erwarteten Weise ausdehnen. Auch der glänzend durchgeführten Chlorat-Elektrolyse setzte der Konsum bald feste Grenzen.

ZINN

Zinn wird nicht nur aus Erzen gewonnen, sondern auch in mehr als 20 in den verschiedenen Ländern der Erde befindlichen Entzinnungsanstalten von den Weissblechabfällen und gebrauchten Büchsen zurückerhalten. Auf diese Weise werden jährlich 200,000 tons verzinntes Eisenblech verarbeitet und Produkte—Zinn und Eisen—im Werte von etwa 24 Millionen Mark erzeugt. Bei dieser Verarbeitung ist da, wo Chlorzinn gebraucht wird, das bisherige elektrolytische Verfahren der hohen Arbeitslöhne, der bedeutenden Stromkosten und der erheblichen Fabrikationsverluste wegen durch die der Firma *Th. Goldschmidt* in Essen geschützte Chlorentzinnung überholt worden. Die letztere beruht auf der Eigenschaft des Chlorgases, in trockenem Zustande sich gierig mit Zinn zu verbinden, ohne bei Einhaltung bestimmter Temperaturgrenzen das Eisen anzugreifen. An Stelle des minderwertigen elektrolytischen Zinnschlammes, der erst durch ein teueres Verhüttungsverfahren in marktfähiges Zinn umgewandelt werden muss, erhält man hier wertvolleres wasserfreies Zinnchlorid, das beim Beschweren der Seide in grossen Mengen verbraucht wird. Diese Chlorentzinnung arbeitet nicht, wie das elektrolytische Verfahren, mit losen Abfällen, sondern von vornherein mit in feste Pakete gepressten Materialien, wodurch in die Apparate die 20 fache Menge hineingebracht werden kann. Ausser in einigen europäischen Fabriken wird dieses neue Verfahren auch hier in New York, durch die Goldschmidt *Detinning Company* ausgeführt.

REDUKTIONS-UND OXYDATIONSMITTEL

Hydrosulfit. Einer der grossartigsten technischen Erfolge ist dem zielbewussten wissenschaftlichen Arbeiten über ein jahrelang unbeachtet gebliebenes, ja nicht einmal richtig erkanntes Präparat beschieden gewesen. Das alte *Hydrosulfit Schützenbergers* hat sich indem man es als *wasserfreies Natronsalz* oder als *Rongalit* in Verbindung mit Formaldehyd, haltbar und in Pulverform leicht transportabel machte, zu einem grossen Handelsartikel entwikkelt. Es wird hauptsächlich in der Küpenfärberei, aber auch zu anderen Reduktionszwecken, z. B. zum Abziehen von Farbstoffen von Geweben, als *Decrolin* und zum Bleichen in der Zuckerindustrie benutzt.

Wasserstoffsuperoxyd. (Persulfate und Perborate). Weit geringer ist bis jetzt die Verbreitung des Wasserstoffsuperoxyds und seiner aussichtsreichen Abkömmlinge geblieben, obgleich es neuerdings auch den *Farbenfabriken vorm. Friedr. Bayer & Co.* gelungen ist, das leicht zersetzliche und ebenfalls in wässeriger Lösung schwer versendbare wichtige Oxydationsmittel durch Addition von Harnstoff fest und haltbar zu machen. Als *Ortizon* wird diese relativ teuere Verbindung weniger für technische, mehr für hygienische und pharmazeutische Zwecke in den Handel gebracht.

Der schönen Darstellung des *Natriumsuperoxyds* aus Natrium und den vielen wissenschaftlichen Untersuchungen der Persalze ist trotz der Persulfate und Perborate, von denen das letztere als Persil für Bleichzwecke gebraucht wird, kein allzu grosser Absatz gefolgt, weil es bisher nicht möglich war, auch diese Körper genügend billig herzustellen.

SELTENE METALLE

Im Gebiete der *Cer-* und *Thorium*präparate ist dem Bedarf für die Glühlichtindustrie, trotz *Muthmanns* und *Auers* interessanten funkensprühenden Legierungen, keine Grossfabrikation gefolgt. Neben den Thoriumsalzen wird nur dieses *Auermetall*, bestehend aus 35% Eisen und 65% Cer, für Feuerzeuge, in beschränktem Umfange gebraucht.

Nachdem man gelernt hat, durch Hämmern die Moleküle des *Wolframs* so eng an einander zu treiben, dass sie sich dem Drahtziehprozess fügen, ist das bei ca. M2,300° schmelzende *Tantal* von dem am höchsten von allen Metallen, nämlich bei 3,100° schmelzenden Wolfram in der Metallfadenlampen-Industrie überholt worden. Die Elemente *Cadmium, Selen* und *Tellur* gewinnt man jetzt und zwar ersteres in der Zinkindustrie, letztere bei der Verarbeitung der Tellurgolderze, wie sie in Cripple Creek gewonnen und in Colorado verarbeitet werden, als Nebenprodukte in grösseren Mengen. Sie werden zu relativ billigen Preisen auf den Markt gebracht, finden aber trotzdem noch keine grössere Verwendung.

KÜNSTLICHE EDELSTEINE

Endlich muss ich noch, wenn auch nur mit einem Wort, der neuen Industrie der aus Tonerde unter Zusatz von Chromoxyd bezw. Eisenoxyd und Titansäure erzeugten synthetischen Edelsteine, der künstlichen roten Rubine und der weissen, gelben und blauen Saphire gedenken, welche mit den natürlichen zum Verwechseln ähnlich sind und sowohl in Paris wie seit kurzem auch von den *Elektrochemischen Werken in Bitterfeld* als Schmucksteine und besonders als Lagersteine für Uhren und Messinstrumente in grösseren Mengen hergestellt werden.

So zeigt die anorganische Chemie ein glänzendes Bild ihrer Entwickelung und gewinnt neben der organischen Chemie eine immer grössere Bedeutung.

ORGANISCH-CHEMISCHE TECHNIK

Bei der organisch-chemischen Technik sind die Reaktionen wesentlich komplizierter und die Apparate meist kleiner wie in der anorganischen Technik. Wie der Jongleur mit seinen Bällen, so muss der Chemiker hier mit den Atomkugeln umzugehen verstehen und jedem Atom in den tausenden und abertausenden von Verbindungen, die der Kohlenstoff mit den 4 Elementen, Wasserstoff, Sauerstoff, Stickstoff und Schwefel eingeht, eine bestimmte Stellung zuweisen. Auch die mannigfaltigsten

Wege und Verfahren führen hier zum gleichen Ziel. Diese Chemie des Kohlenstoffs finden wir technisch am höchsten und vollkommensten in der *Teerfarbenindustrie* ausgebildet, wo in jeder der grösseren Fabriken mehrere Hundert wissenschaftlich gebildete Chemiker tätig sind, um täglich neue Verbindungen mit technisch verwertbaren Eigenschaften ausfindig zu machen. Ehe aber diese Produkte mit färbenden, wohlriechenden, therapeutischen oder anderen technischen Eigenschaften als Farbstoffe, Riechstoffe, pharmazeutische Präparate oder technische Artikel fabrikmässig hergestellt werden können, müssen sie eine Reihe von Fabrikationsprozessen durchlaufen. Aus zahllosen Zwischenprodukten werden erst die marktfähigen Chemikalien aller Art erhalten.

STEINKOHLENTEER

Der Grundstoff dieser hochbedeutenden Teerfarbenindustrie ist der schwarze Teer, der durch trockene Destillation der Steinkohle gewonnen wird. Er enthält bekanntlich etwa 150 verschiedene chemische Körper. Von diesen spielen neben der Carbolsäure die aromatischen Kohlenwasserstoffe, *Benzol* und seine Homologen, *Toluol* und *Xylol* sowie *Naphtalin, Anthracen* die grösste Rolle.

In neuester Zeit ist man auch zur Abscheidung des *Carbazols* übergegangen, nachdem es der Firma *Leopold Cassella & Co.* in Frankfurt a. M. gelungen war, daraus einen sehr wichtigen, durch seine Wasch- und Chlorechtheit ausgezeichneten blaufärbenden Schwefelfarbstoff, das *Hydronblau,* zu machen. Auch das *Acenaphten* wird gewonnen, seitdem die *Gesellschaft für chemische Industrie* in Basel daraus einen küpenfärbenden roten Farbstoff, das *Cibanonrot,* herstellt. Leider hat sich für das auch im Teer vorkommende *Phenanthren* eine Verwendung bisher nicht finden lassen. Ausser der Carbolsäure werden neuerdings auch ihre Homologen, die verschiedenen *Kresole,* von der Firma *Dr. F. Raschig* in Ludwigshafen a. Rh. isoliert; sie finden in der Sprengstoffindustrie und auch für Farbstoffzwecke Verwendung.

So lange noch Steinkohlengas, sei es zur Beleuchtung oder Heizung, hergestellt und so lange Koks zur Reduktion der Eisenerze verwendet wird, so lange wird der Teer auch das billigste Ausgangsmaterial zur Gewinnung dieser Kohlenwasserstoffe bilden.[1]

Da es nun möglich und später vielleicht auch notwendig ist, die sämtlichen Kohlen in rationellerer Weise unter Gewinnung dieser Kohlenwasserstoffe zu verarbeiten, so braucht die Teerfarbenindustrie einen Mangel an diesen wichtigen Rohstoffen nicht zu fürchten; dies umso weniger, als bestimmte Petroleumsorten, wie z. B. das Borneopetroleum, grössere Mengen aromatischer Kohlenwasserstoffe enthalten und die *Benzinwerke Rhenania* in Reisholz bei Düsseldorf daraus schon heute das Toluol in Form von Nitrotoluol isolieren und der deutschen Anilinindustrie zur Verfügung stellen. Sollte aber einmal ein grösserer Bedarf an diesen Kohlenwasserstoffen eintreten, so müssen andere Wege zu ihrer Gewinnung gesucht werden. Es wird dann sicher gelingen sie synthetisch darzustellen, sei es direkt aus den Elementen Kohlenstoff und Wasserstoff, sei es auf dem Umwege über das Calciumcarbid beim Durchleiten von Acetylen durch glühende Röhren, wie es in den sechziger Jahren des vorigen Jahrhunderts *Berthelot* und neuerdings *Richard Meyer* mit Erfolg getan hat.

TEERDESTILLATION

Der Schwerpunkt bei der Teerdestillation liegt immer noch bei der möglichst billigen Abscheidung und Trennung der einzelnen Kohlenwasserstoffe in reiner Form. Man hat dabei die Destillationsapparate immer mehr vergrössert und wendet heute solche von 60,000 bis 80,000 Liter Inhalt an. Dagegen ist ein kontinuierlicher Betrieb, wie er sich beim Braunkohlenteer durchführen lässt, noch nicht gelungen. Eine grosse Zahl von Patenten auf Apparate, welche dieses Problem lösen sollten, sind zwar genommen worden, doch hat sich keines in der Praxis bewährt.

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[1] Zur Zeit werden von der Gesamtkohlenproduktion Deutschlands an Steinkohle ca. ein Viertel verkokt, und zwar 20% auf Hüttenkoks und nur 4% auf Leuchtgas verarbeitet, während die entsprechenden Mengen in England 12% und 6% der Gesamtkohlenförderungen betragen.

ORGANISCHE ZWISCHENPRODUKTE

Die Umwandlung der aromatischen Kohlenwasserstoffe in die für die Farbenfabrikation notwendigen Zwischenprodukte wird fast immer durch Behandeln mit konzentrierter Schwefelsäure und Salpetersäure und durch Reduktion der so gebildeten Nitroverbindungen unter Zuhilfenahme von Metallen, Metalloxydulsalzen und Metallsulfiden bewirkt, wobei zur Herstellung der Amine das Eisen, zur *Darstellung* der Azoverbingungen das Zink und das Eisen hauptsächlich in Betracht kommen. Die elektrolytische Reduktion hat sich bei all diesen Prozessen bis jetzt nicht bewährt.

Die Darstellungsverfahren der *Nitro-* und *Amidoverbindungen* haben in ihrem Chemismus wenig Aenderung erfahren, während die Giftigkeit dieser Verbindungen, die mit der Erhöhung der Produktion immer mehr in die Erscheinung trat, die chemische Industrie zwang, die Verfahren so zu modifizieren, dass sie jetzt ohne Gefahr für Leben und Gesundheit der Arbeiter in ganz geschlossenen Apparaten ausgeführt werden.

Die Gesetzgebung in Deutschland ist sogar in neuester Zeit dazu übergegangen, aus den so gewonnenen Erfahrungen der grossen Betriebe Grundzüge für Einrichtung und Betrieb derartiger Fabrikationsanlagen nach der hygienischen Seite hin festzulegen.

Manche Trinitroverbindungen sind als gute Sprengstoffe erkannt worden und haben, wie z. B. das Trinitrotoluol, als Ersatz für die Pikrinsäure in der Sprengstoffindustrie ausgedehnte Verwendung gefunden.

Die Einführung von *Oxygruppen* erfolgt meist durch Verschmelzen von Sulfosäuren mit Alkalien und neuerdings auch mit Erdalkalien, wie Kalk- und Barythydrat. Seitdem das elektrolytische Chlor in unbegrenzter Menge und reiner Qualität zur Verfügung steht, hat man auch die *Chlorsubstitutionsprodukte* der Kohlenwasserstoffe zu allen möglichen Zwecken herangezogen. Viele dieser Chlorderivate sind nicht nur befähigt, durch Verschmelzen mit Alkalien in Oxyverbindungen überzugehen, sondern sie tauschen auch, wie das Paranitrochlorbenzol, beim Behandeln mit Ammoniak und seinen Abkömmlingen das

Chlor gegen Amidoreste direkt aus. Auch die Farbstoffe selbst, in welche man ein Halogenatom einführt, zeigen oft veränderte Nüancen und wertvollere Eigenschaften, als die nicht chlorierten Produkte. So hat sich die Verwendung des Chlors zur Darstellung von Zwischenprodukten als äusserst wertvoll erwiesen und wird ohne Zweifel künftighin dem Chemiker noch manchen guten Dienst leisten.

In der Naphtalinreihe hat sich das von *Bucherer* bezw. *Lepetit* gefundene, über die *Schwefligsäureester* führende Verfahren zur Umwandlung der Hydroxyl- in die Amidogruppe und umgekehrt sehr gut eingeführt. Auch das *Phosgen,* das schon vor Dezennien zur Herstellung des Harnstoffs aus Paraamidobenzolazosalicylsäure in Form des schönen lichtechten Baumwollgelbs Bedeutung erlangt hatte und vor allem zur Herstellung der brillanten, aber lichtunechten Triphenylmethanfarbstoffe verwendet wurde, findet, indem man es auf aromatische Verbindungen mit freien Amidogruppen einwirken lässt, in Form von Harnstoffderivaten mehr und mehr Anwendung, da die daraus hergestellten anderen Azofarbstoffe auch lichtechter sind. Auch werden *Imidazol-, Thiazol-* und *Azimido*-Verbindungen der verschiedensten Art dargestellt und auf Azofarbstoffe verarbeitet.

In der Reihe der *Aldehyde* und *Carbonsäuren* sind keine bahnbrechenden Fortschritte zu verzeichnen. Man geht hier immer noch von den in der Seitenkette chlorierten Kohlenwasserstoffen aus oder oxydiert die Homologen des Benzols direkt. Die *Kolbesche* Synthese der Salicylsäure, von der sehr grosse Mengen zur Herstellung von Azofarbstoffen verbraucht werden, findet auch zur Darstellung anderer Oxycarbonsäuren immer grössere Anwendung. Dabei ist die direkte Einführung der Carboxylgruppe in den nicht hydroxylierten Benzolkern ein erwünschtes, aber ungelöstes Problem geblieben. Ebenso ist es ein dringendes Bedürfnis, bei Substitutionen im aromatischen Kern das Mengenverhältnis der entstehenden Isomeren nach Wunsch variieren zu können. Ausser der biochemischen Darstellung von Spiritus aus Sägespähnen bezw. den Sulfitcelluloseabfalllaugen, wäre noch der synthetische Aufbau von organischen Verbindungen aus dem Kohlenstoff durch Anlagerung von Wasser an das Acetylen zu erwähnen. Auf einfache Weise erhält man so den reaktionsfähigen Acetaldehyd, der leicht in Essigsäure übergeführt werden kann. Bekanntlich ist aber die Essigsäure ein wichtiges Ausgangsmaterial zur Herstellung zahlreicher anderer Produkte.

So ist das Suchen nach neuen Ausgangs- und Zwischenprodukten, die für die Farbstoffdarstellung geeignet sind, vielfach von Erfolg gekrönt gewesen. Man denke nur an die vielen Zwischenprodukte, welche auf dem Gebiete der Küpen- und Schwefelfarbstoffe aufgefunden wurden und hier zu neuen Produkten mit wertvollen Eigenschaften führten. Sehr oft wird auch hier nicht nur zielbewusst, sondern durch Zufall eine neue Bahn erschlossen. Aber immer ist gute Beobachtungsgabe nötig, um Erfolge zu erzielen und deshalb wird es dem Chemiker möglich sein, hier noch manche wertvolle Frucht zu ernten.

TEERFARBSTOFFE

Kein Gebiet der technischen Chemie hat aber eine solch intensive Bearbeitung erfahren, wie dasjenige der Teerfarbstoffe selbst. Schon längst konnte der Fernstehende den Eindruck gewinnen, es sei hier soviel geschehen, dass nichts mehr zu tun übrig bleibt. Die Unzahl der Farbstoffe in allen Tönen des Regenbogens mussten den Glauben erwecken, eine Ueberproduktion sei vorhanden. Aber hier ist es so ergangen, wie es in der Regel im Leben zu gehen pflegt. Mit zunehmendem Besitz wuchsen die Bedürfnisse und Ansprüche. Während man früher zufrieden war, wenn man mit den künstlichen Farbstoffen alle denkbaren Nüancen auf einfachstem Wege und in ungeahnter Pracht erzeugen konnte, fing man allmählich an, die Ansprüche an die Echtheit höher zu schrauben. Die Stoffe sollten nicht nur schön gefärbt, sie sollten zugleich auch wasch- und lichtecht sein. Damit boten sich dem Farbenchemiker neue lockende Probleme dar, und bei seinem unverdrossenen Streben ist er der Lösung schon einen guten Schritt näher gekommen.

Merkwürdigerweise ist man im Publikum auch jetzt noch vielfach der Ansicht, dass die Farbenchemie in der Echtheitsfrage versage. Das ist ein Irrtum, dem nicht energisch genug entgegengetreten werden kann. Auf jedem Stoff, sei es Wolle, Baumwolle, Seide oder Papier, kann man heute jede Nüance in jeder nur gewünschten Echtheit herstellen. Wenn es meist nicht geschieht, so liegt das ausschliesslich daran, dass das Publikum seine Wünsche nicht mit dem nötigen Nachdruck vertritt. Die unumgänglichen, aber nicht wesentlichen Mehrkosten, welche die Echtfärberei verursacht, müssen allerdings willig getragen werden.

Ehe ich der Fortschritte gedenke, die auf dem Gebiete der echten Farbstoffe erzielt sind, möchte ich, um Missverständnissen vorzubeugen, hier ausdrücklich betonen, dass auch die alten, weniger echten oder oft in irgend einer Eigenschaft ganz unechten Produkte nach wie vor ihre Existenzberechtigung haben. Es wäre ja ganz zwecklos, z. B. solche Papiere, denen nur ein Eintagsdasein bestimmt ist, mit absolut lichtechten Farbstoffen zu färben, Stoffe, die niemals gewaschen werden, mit waschechten teuren Farbstoffen zu veredeln, oder Unterstoffe, die kaum das Tageslicht zu ertragen haben, wie Waren zu behandeln, von denen der höchste Grad der Lichtechtheit verlangt wird. Alles an seinem Platze! Aber für viele Zwecke ist das Bedürfnis, nach lichtechten oder licht- und waschechten Färbungen so gross, dass ihm unbedingt Rechnung getragen werden muss. Wie verdriesslich ist es nicht für einen jeden, der seine Wohnung mit den schönsten und wertvollsten Wandbekleidungen versehen hat, wenn er schon nach kurzer Zeit sehen muss, wie die ursprüngliche Pracht immer missfarbiger wird, wie in verschossener Umgebung ein einsamer Fleck in alter Schönheit aufleuchtet, sobald man ein Bild oder Möbelstück verschiebt. Da man sich gegen solche Misstände schützen kann, so soll man es tun. Wir sind heute in der Lage, die schönsten farbigen Wandbekleidungen, sei es aus Papier, sei es aus gewebten oder bedruckten Stoffen herzustellen, die allen Ansprüchen genügen. Das zeigt Ihnen die grosse Kollektion von belichteten und gewaschenen Woll-und Baumwollstoffen aller Art, wie vor allem auch von Tapeten und Teppichen, selbst Gummi- und Ballonstoffen, wie solche mir von den verschiedenen Firmen der Farben- und Färberei-industrie überlassen worden sind.

Wenn Sie mich nun fragen, auf welche Weise der Chemiker diese Fortschritte erzielt hat, so kann ich nur antworten durch unverdrossenes und zielbewusstes Vordringen auf allbekannten Wegen, durch energisches Verfolgen der geringsten sich zeigenden Spuren des Fortschritts, wobei Misserfolge den Forscher nicht abschrecken dürfen. Auf allen Gebieten der Farbstoffchemie sind so echte und immer echtere Farbstoffe ausfindig gemacht worden, von den früher als licht- und waschunecht verschrieenen bunten Benzidinfarbstoffen bis zu den indigoiden und den Anthrachinon-Farbstoffen. Bei all diesen Klassen hat man allmählich Gesetzmässigkeiten in der Gruppierung der Komponenten und in der Stellung der Substituenten kennen gelernt, die es ermöglichen, planmässig und mit Erfolg auf Erhöhung der Lichtechtheit hinzuarbeiten.

So wurden auf dem Gebiet der Azofarbstoffe die lichtechten Wollfarben und die substantiven lichtechten Baumwollfarben und auf dem Gebiet der Schwefelfarben unter anderen die *Hydronblaus* gefunden.

INDIGOIDE FARBSTOFFE

Die Synthese der indigoiden Farbstoffe gewann Leben durch die erfolgreiche Einführung des künstlichen Indigos, der das Naturprodukt fast verdrängt und die Aufmerksamkeit sowohl der Chemiker wie der Konsumenten in erhöhtem Masse auf die Vorteile der Küpenfärberei gelenkt hat. Neben dem Könige der Farbstoffe, dem Indigo, sind jetzt zahlreiche andere Farbstoffe, *Bromindigos*, *Thioindigos* und *Alizarinindigos* in allen Abstufungen von blau bis zu rot, violett, grau und schwarz aufgefunden worden, darunter auch der kostbare *Purpur der Alten*. Paul Friedlaender hat gezeigt, dass dieser aus der im Mittelmeer lebenden Purpurschnecke durch Ausdrücken bestimmter Drüsen gewonnene Farbstoff identisch ist mit einem schon lange bekannten und auf synthetischem Wege dargestellten Dibromindigo. Alle diese neuen indigoiden Farbstoffe zeigen fast durchgehends die gleichen oder noch besseren Eigenschaften, als der Indigo selbst.

ALIZARINFARBSTOFFE

Die Echtheit der Alizarinfarbstoffe, z. B. des Alizarinrots, als Türkischrot, war seit uralten Zeiten bekannt. Aber während man früher nur Beizenfarbstoffe für echt hielt, und deshalb nur solche in der Anthrachinonreihe, wie das Alizarin-orange und-braun, die Alizarinblaus, und Alizarincyanine etc. darstellte, gelang es 1894 bis 1897 *Robert E. Schmidt*, auch sauer färbende Anthrachinonfarbstoffe in allen möglichen Nüancen aufzufinden, die an Klarheit und in der Einfachheit ihrer Anwendungsweise den altbekannten Triphenylmethanfarbstoffen an die Seite zu stellen sind, dabei aber die hervorragende Lichtechtheit der beizenfärbenden Alizarinfarbstoffe besitzen. Ich nenne hier nur das *Alizarincyaningrün*, das *Alizarinreinblau*, das *Anthrachinonblau*, das *Alizarin-saphirol,-astrol,-irisol* und-*rubinol*. Die Lichtechtheit dieser Farbstoffe und ihre bequeme Anwendungsweise sind so vorzüglich, dass z. B. in der berühmten Manufacture Nationale des Gobelins in Paris diese Farbstoffe an Stelle der bis dahin gebrauchten traten, um die bei den Gobelins zur Verwendung kommende Wolle damit zu färben. Das beweist viel, wenn man bedenkt, dass der Quadratmeter dieser Gobelins, zu dessen Herstellung ein Arbeiter mehr als ein Jahr braucht, durchschnittlich für Frs. 6,000.—verkauft wird.

INDANTHREN-UND ALGOLFARBSTOFFE

Eine ganz neue Bewegung aber setzte auf dem Alizaringebiete ein, als es *René Bohn* im Jahre 1901 gelang, in dem *Indanthren* auch einen Küpenfarbstoff für Baumwolle herzustellen, der sich wie der Indigo im reduzierten Zustande färben liess, letzteren an Schönheit und Lebhaftigkeit, aber auch an Waschechtheit und Lichtechtheit noch erheblich übertraf. Die Lichtechtheit ist so gross, dass sie als unvergänglich bezeichnet werden kann.

Indanthrenblau hat infolge dieser phänomenalen Echtheitseigenschaften den Anlass gegeben, in der Anthrachinonreihe nach weiteren Küpenfarbstoffen zu suchen. Der Erfolg ist nicht ausgeblieben, und schon heute verfügen wir über eine grosse Schaar derselben. Von der *Badischen Anilin- und Soda-Fabrik* werden sie unter dem Namen *Indanthrenfarbstoffe, von* den *Farbenfabriken vorm. Friedr. Bayer & Co.* unter dem Namen *Algolfarbstoffe* in den Handel gebracht. Diese Farbstoffe gehören chemisch zum Teil dem Typus der Indanthrene an, zum Teil sind es noch kompliziertere ringförmige Kondensationsprodukte mehrerer Anthrachinonmoleküle, zum Teil sind es Di- und Trianthrachinonylamine. Sehr bemerkenswert ist, dass, wie im Laboratorium der *Farbenfabriken vorm. Friedr. Bayer & Co.* zur grossen Ueberraschung aller Sachverständigen gefunden wurde, schon die einfachen Acyl (-Benzoyl) Derivate der Aminoanthrachinone, hervorragende Küpenfarbstoffe sind.

LACKFARBEN

Aber auch für die Herstellung von Körperfarben, für Tapeten- und Anstrichzwecke, für die sogenannten Lacke sind bestimmte Anilin-und vor allem auch die Anthrachinonfarbstoffe von Wichtigkeit. Bekannt ist der so schöne und lichtechte Tonerdelack des Alizarins, der *Krapplack.* Aber auch andere Alizarinfarbstoffe geben wertvolle Tonerdelacke, so z. B. das *Alizarinsaphirol* einen hervorragend lichtechten blauen Lack. Dabei ist es nicht einmal notwendig, ihre Lacke herzustellen. Die meist sehr schwer löslichen Küpenfarbstoffe selbst können direkt in fein verteilter Form benutzt werden. So spielt das Indanthrenblau und Algolblau schon heute eine bedeutende Rolle, als Ersatz von Ultramarin zum Bläuen von besseren Papieren, von Geweben und selbst von Zucker.

Die Entwickelung der Anthracenfarbstoffe ist auch in anderer Hinsicht bemerkenswert. Nicht nur in tinktureller, sondern auch in chemischer Beziehung sind manche überraschende und eigenartige Reaktionen dabei entdeckt worden, wie z. B. die seltsame Wirkungsweise der Borsäure und die katalytische Wirkung des Quecksilbers beim Sulfieren des Anthrachinons.

Wir stehen aber auf diesem Gebiete noch mitten in der Entwickelung. Noch bleiben viele Probleme zu lösen und immer tauchen neue auf. Viele Farbstoffe sind hier noch zu machen, um den Bedürfnissen der Färberei zu genügen.

Sicherlich wird es dem rastlosen Streben der Farbenchemiker gelingen, auch hier immer weiter und weiter zu kommen und die vielfach so berechtigten Klagen über mangelnde Echtheit der gefärbten Stoffe zum Verstummen zu bringen. Soll dieses Ziel erreicht werden, dann ist es von dem Konsumenten aber auch unbedingt erforderlich, den Produzenten in seinen Bemühungen zu unterstützen, und bei dieser Gelegenheit möchte ich nicht versäumen, festzustellen, *dass gerade in den Vereinigten Staaten von Nordamerika diese echteren Farbstoffe am meisten gebraucht werden und früher als in allen anderen Ländern Anerkennung und weitverbreitete Anwendung gefunden haben.*

PHARMAZEUTISCHE CHEMIE

Die synthetische Darstellung von Heilmitteln, die pharmazeutische Chemie, mit deren Fortschritten und Problemen wir uns nunmehr kurz beschäftigen wollen, ist die jüngste Schwester der Teerfarbenindustrie; sie hat noch nicht lange ihr silbernes Jubiläum hinter sich. Wer, wie ich, das Glück hatte, an ihrer Wiege zu stehen, als *Antipyrin* von *Ludwig Knorr* gefunden wurde und seine ersten noch unbeholfenen Schritte zu lenken, als *Phenacetin* und *Sulfonal* entstanden, der muss freudigen Herzens auf diese Zeit glänzender Entwickelung zurückschauen. Es ist viel tüchtige Arbeit geleistet worden, aber es bleibt noch unendlich viel zu tun übrig. Hier sehen wir Chemie und Medizin innig miteinander verbunden, eine auf die andere angewiesen und ohne die Hilfe der anderen machtlos. Und welcher Apparat gehört dazu, welche Unmenge von Intelligenz ist erforderlich, wieviele Kräfte sind nötig, um ein neues synthetisches Heilmittel ausfindig zu machen und ihm seinen Weg durch die Klippen des Verkehrs zu ebnen. Voran ein mit allen Hilfsmitteln ausgerüstetes chemisches Laboratorium; ihm zur Seite ein pharmakologisches Institut mit chemisch-medizinisch geschulten Kräften und einem reichen Tiermaterial; daneben das neueste auf diesem Gebiete, eine nach Ehrlichs Vorbild ausgerüstete chemo-therapeutische und bakteriologische Abteilung; alles im engsten Kontakt miteinander. Was da ersonnen, probiert und nach vielen Mühen als brauchbar ausgelesen wird, wandert dann in die Fabrikationsabteilungen und wird hier bis in die kleinsten Einzelheiten hinein durchgearbeitet und zur grossmöglichen Vollendung gebracht. Dann beginnt das wissenschaftliche Bureau seine mühevolle Arbeit. Da gilt es, die richtigen Zeugen zu finden, die das Kind aus der Taufe heben, da müssen Vorurteile aller Art entkräftet werden und eine grosszügige Propaganda einsetzen. Da muss endlich auch draussen das grosse Heer der Kliniker und Praktiker unserer Freunde und Mitarbeiter aufgeboten werden, damit das in stiller Werkstatt Ersonnene auf sicherem Schiff hinausgeleitet wird in's weite Meer der Oeffentlichkeit. Und endlich muss der rechnende Kaufmann alles wieder einbringen, was die Unzahl vergeblicher Versuche gekostet hat, soll das Werk, das so grosse Mittel verschlingt, bestehen können und sich gedeihlich weiter entwickeln. Wahrlich eine Arbeit, die leider viel zu oft verkannt und nicht genügend gewürdigt wird. Ist aber einmal, was nur alle Jubeljahre vorkommt, ein grosser Wurf gelungen, dann heften sich die Neider, die Patent- und Namensschutzverletzer an unsere Fersen und suchen den wirklich nicht grossen Verdienst dieser Industrie zu rauben.

Unbekümmert darum aber arbeitet diese, leider heute auch von Apothekern und Aerzten bekämpfte, pharmazeutische Industrie unverzagt weiter. Denn wir erfüllen neben wirtschaftlichen Aufgaben auch ideale Pflichten; wir bekämpfen systematisch die Symptome der Krankheiten und werden so die getreuen Helfer des Arztes und der geplagten Pfleger. Den nagenden Schmerz der Kranken lindern wir mit narkotischen und anästhesierenden Substanzen. Den Schlaf, der das Leidenslager flieht, zwingen wir in unseren Dienst; das Fieber bannen wir. Die kleinen Lebewesen, die vielfach die Ursache und Träger der Krankheiten sind, töten wir ab. So ergänzen wir das Bewährte, verbessern das Bestehende. Wir isolieren auch aus geschätzten Drogen das wirksame Prinzip und garantieren damit eine exakte Dosierung und den Wegfall unerwünschter oder gar gefährlicher Nebenwirkungen.

Die hohe chemische Wissenschaft, sie kommt bei uns voll und ganz zu ihrem Recht. Auf allen Gebieten der anorganischen, organischen und physiologisch-biologischen Chemie sind wir mit einem Heer von wissenschaftlich geschulten Kräften tätig. Glänzende chemische Synthesen gelangen uns. Noch zuletzt der Aufbau des *Adrenalins*[1] (*Suprarenin*) durch *Stolz*, des *Hydrastinins* durch *Decker*, der *Purinbasen* durch *Emil Fischer* und *Wilhelm Traube*. Alles das sind Ruhmestaten und gar vieles davon wurde in den Laboratorien der Industrie gefunden.

Dass uns aber auch jetzt noch, wie im Anfang, zur Zeit des Antifebrins, der Zufall helfen muss, zeigt die Ausmittelung des neuesten bewährten Gichtmittels, des *Atophans*, die einer glücklichen zufälligen Beobachtung zu danken ist. Auch in das alte *Mutterkornproblem* bringt die Forschung allmählich Licht und rückt die Möglichkeit synthetischer Ersatzstoffe in greifbare Nähe. Dabei zeigt sich, dass die hämostyptisch wirksamen Stoffe eine verhältnismässig recht einfache Konstitution besitzen. Dass in unserem Zeitalter der Nervosität *Sedativa* ihre Stätte finden, wird nicht Wunder nehmen. Es sei nur an das neue *Adalin*, das sich vortrefflich bewährt, erinnert. In der jüngsten Zeit ist es dem Meister chemischer Forschung, *Emil Fischer*, dem die pharmazeutische Industrie neben den synthetischen Purinbasen *Coffein*, *Theobromin* und *Theocin* auch geschätzte Medikamente, wie *Veronal* und *Sajodin* zu danken hat, die so lange vergeblich versuchte Konstitutionsaufklärung und *Synthese des Tannins* gelungen. Durch die damit ermöglichte künstliche Darstellung von *Gerbstoffen* aller Art ist ein neues aussichtsvolles Gebiet der Forschung erschlossen worden.

CHEMOTHERAPIE

Auf ein anderes zukunftsvolles Gebiet der pharmazeutisch-medizinischen Chemie hat aber *Ehrlich* erst vor kurzem die Aufmerksamkeit gelenkt, die Behandlung von Infektionskrankheiten durch chemische Mittel. Durch jahrelange emsige Arbeit, durch tausende und abertausende von Versuchen an Tieren gelang ihm, dem Meister der Medizin und der Chemie, der Nachweis, dass man chemische Substanzen herstellen kann, die die Parasiten innerhalb des Körpers töten, ohne den Wirt selbst zu schädigen, und dass diese Wirkung eine Funktion der chemischen Konstitution ist. So ging der Weg dieser neuen Wissenschaft, die Zauberkugeln verwendet, welche nur auf die Schädlinge des Körpers gerichtet sind, den Organismus selbst und seine Zellen aber nicht beeinflussen, über die Aminophenylarsinsäure—das *Atoxyl*—zum Diaminodioxyarsenobenzol—dem *Salvarsan*. Zu den alten bewährten Heilmitteln dem *Quecksilber*, *Chinin* und der *Salicylsäure*, gesellte sich so ein neues synthetisches Präparat aus der Reihe der Arsenikalien. Es ist sicher, dass wir hier erst am Anfang einer neuen Entwickelung stehen. Wir wissen schon, dass wir nicht nur Spirochäten, sondern so auch Bakterienkrankheiten, wie die Tuberkulose, bekämpfen können. Ja selbst die noch nicht in ihren Ursachen erforschten Krankheiten, die Menschheit würgenden *Carcinome* und *Sarcome* sind wahrscheinlich, wie *Emil Fischer* zuerst gefunden hat, auf diesem Wege und zwar mit Selenverbindungen bestimmter Art zu beeinflussen. Aber wenn wir erst die auf Trypanosomen beruhenden Krankheiten zu heilen lernen, welche Grosstat im Interesse der Menschheit und der Volkswirtschaft wäre damit vollzogen, wo gerade die fruchtbarsten Länder der Erde von diesen Krankheiten befallen sind, die Mensch und Tier der rettungslosen Vernichtung überliefern. Weder Salvarsan noch Atoxyl leisten bei der Schlafkrankheit die gewünschten Dienste. Es müssen hierfür andere, noch nicht bekannte Heilmittel gesucht werden.

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[1] 1 kg Adrenalin, das jetzt synthetisch hergestellt und unter dem Namen Suprarenin von den Höchster Farbwerken in den Handel gebracht wird, erfordert zu seiner Herstellung aus den Nebennieren solche von 40,000 Ochsen. Dieses Product, wie zahlreiche andere Drüsenpräparate, werden heute auch von grossen amerikanischen Schlachthäusern selbst hergestellt.

Auch die Behandlung der *Syphilis* mit ihren schrecklichen Folgen ist noch keine vollkommene, trotz Quecksilber und Salvarsan, doch steht zu hoffen, dass im Laboratorium durchgeführte systematische Versuche mit den zahllosen Produkten, welche die Chemie in Verbindung mit Quecksilber und Arsen darzustellen vermag, auch in der Praxis Erfolge zeigen werden.

RIECHSTOFFE

Auf dem Gebiete der Riechstoffe sind, seit der Duft des Veilchens mit dem Jonon nachgebildet wurde und seitdem die synthetische Darstellung des Kampfers aus dem Terpentinöl gelang, keine so erheblichen Fortschritte gemacht worden, dass wir lange bei dieser ebenfalls bedeutungsvollen und mit einem jährlichen Umsatz von 45 bis 50 Millionen Mark rechnenden Industrie zu verweilen brauchen. Die Tätigkeit der Chemiker ist hier darauf gerichtet, die komplexen und einfachen natürlichen Riechstoffe zu erforschen und in ihre einzelnen Bestandteile zu zerlegen, um sie dann aus synthetisch hergestellten Produkten wieder aufzubauen, wie dies beim Rosenöl, Maiglöckchen-und Veilchenblütenöl mit Erfolg geschehen ist. Sehr oft sind hierzu Stoffe als Träger des Duftes nötig, die, wie die Indole, weit davon entfernt sind, zu den angenehm riechenden Produkten gezählt zu werden.

KUNSTSEIDE

Wenn man auch zweifelhaft darüber sein kann, ob die Kunstseide—der jährliche Verbrauch wird auf ca. 7 Millionen Kg. geschätzt—der chemischen Industrie noch zugezählt werden darf, da sie schon wegen des Ueberwiegens der bei ihrer Herstellung notwendigen Spinnmaschinen in naher Beziehung zur Textilindustrie steht, so sind doch die zu ihrer Fabrikation notwendigen Ausgangsprodukte, die Nitrocellulose, die Kupferoxydammoniakcellulose und die Cellulose-Xantogenate von so grosser Bedeutung, dass dem Chemiker hier dieselbe Rolle wie dem Ingenieur zufällt. Hier ist die Viscoseseide, aus dem Cellulose-Xantogenat im Begriff, die Nitrocelluloseseide und den Glanzstoff zu verdrängen, nachdem es durch gründliches Studium der chemischen Vorgänge gelungen ist, ihre Herstellung zu verbessern. Tatsächlich hat sie auch von allen Kunstseiden den schönsten Glanz und lässt sich am billigsten fabrizieren, so dass selbst das scheinbar einfachste Verfahren aus Kupferoxydammoniakcellulose im Konkurrenzkampf mit ihr die Segel streichen muss. Von den Vereinigten Glanzstofffabriken zu Elberfeld und ihrer Fabrik Oberbruch in Dremmen bei Aachen ist mir eine schöne Kollektion dieser neuesten Viscoseseide, sowie der Ausgangsmaterialien vom rohen Holz über den Zellstoff, die Alkalicellulose und das daraus mit Schwefelkohlenstoff dargestellte Cellulosexantogenat bis zur fertigen Viscoselösung überlassen worden.

ACETYLCELLULOSE

Cellitfilm. Auf dem Gebiete der acetonlöslichen Acetylcellulose, Cellit genannt, haben sich bisher die von den *Farbenfabriken vorm. Friedr. Bayer & Co.* daraus zuerst dargestellten Kinematographenfilms, welche den Vorzug der Unverbrennlichkeit vor denen aus Nitrocellulose besitzen, noch nicht durchsetzen können. In ihren sämtlichen Eigenschaften sind sie den alten feuergefährlichen Films ebenbürtig, aber die Kinematographentheaterbesitzer wehren sich gegen ihre Einführung, weil sie eine Verwendung des Kinematographen in Schule und Hause möglich machen, was unverständlicherweise als eine Konkurrenz gegen die der strengen polizeilichen Aufsicht unterworfenen Kinematographentheater angesehen wird. Hier kann also nur ein Druck von oben, der die Anwendung der entflammbaren Films erschwert und die Verwendung der Cellitfilms erleichtert, helfen. Es ist Aussicht vorhanden, dass in dieser Weise, in Deutschland wenigstens, bald vorgegangen wird und dass dann die Brände in den Kinematographentheatern aufhören und die damit verbundenen Gefahren für Leben und Eigentum beseitigt werden.

Baykogarn. Wenn sich auch auf dem Gebiete der Baumwollfäden, die mit einer Mischung von Cellit und Metall überzogen sind und von den Farbenfabriken vorm. Friedr. Bayer & Co. unter dem Namen Baykogarn als besserer Ersatz von Gold-und Silberfäden, in den Handel kommen, nichts neues ereignet hat, so möchte ich doch die Gelegenheit nicht vorübergehen lassen, um auch die hier anwesenden Damen auf die schönen Effekte hinzuweisen, die sich bei Wand- und Möbelstoffen, Stickerein etc. mit diesem neuen Produkt der chemischen Industrie erzielen lassen.

Cellon. Das Problem, unverbrennbares Celluloid zu machen, indem man Cellit durch zweckentsprechende Verarbeitung mit schwer brennbaren und nicht brennbaren Kampferersatzmitteln mengt, ist heute als gelöst zu betrachten. *Eichengrün* hat die Fabrikationsweise ausserordentlich vereinfacht, indem er zeigte, dass bestimmte Acetylcellulosen in der gleichen Weise gelatiniert werden können, wie dieses bei der Nitrocellulose möglich ist. Bekanntlich gibt Nitrocellulose mit Kampfer bei Gegenwart eines Lösungsmittels sogenannte starre Lösungen, die sich selbst in getrocknetem Zustand mit Leichtigkeit schneiden, oder in Form von Stäben, Röhren oder Fäden bringen lassen. Auch das Cellit liess sich mit den entsprechenden Kampferersatzmitteln in ganz analoger Weise in das *Cellon* genannte unverbrennliche Ersatzprodukt für Celluloid überführen. So werden heute schon Blöcke von 100 kg Gewicht hergestellt, welche man wie Celluloid sägen, schneiden, fräsen, schleifen und polieren, in der Wärme pressen und biegen und mit Hilfe von heissem Dampf in Formen bringen oder ziehen kann. Das Cellon zeigt auch vor dem Celluloid den Vorteil, dass es von grösserer Plastizität und dabei weicher und dehnbarer ist und deshalb in vielen Fällen als Ersatz für Hartgummi, Guttapercha, Leder etc. benutzt wird. Mit diesem Cellon in Form hochviscoser syrupartiger Lösungen kann man auch Stoffe, Holz, Papier, Metalle etc. mit dicken emailleartigen zusammenhängenden und nicht brüchig werdenden Schichten überziehen und so Lackleder, Kunstleder, Isolationsstoffe, Ballonstoffe etc. herstellen. In Frankreich werden heute schon die Aeroplanflächen mit diesem Lack überzogen. Aus diesem Material mit neuen technischen Eigenschaften und vielseitiger Verwendungsweise sind die vielen, dort ausgestellten Gegenstände der *Rheinisch-Westfälischen Sprengstoff-Actien-Gesellschaft* in Cöln und der *Société Industrielle de Celluloid in Paris* gemacht.

KAUTSCHUK

Endlich komme ich zum Schluss zu einem der grössten Erfolge, aber auch zugleich schwierigsten Probleme der chemischen Industrie, zur Bereitung des künstlichen Kautschuks. Ich bin stolz darauf, dass seine Synthese in dem Werk geglückt ist, dessen Leitung mir obliegt, und dass ich alle Stadien dieser wichtigen Erfindung habe genau verfolgen können. Es wird Sie vielleicht, trotz der vorgerückten Zeit, noch interessieren zu hören, wie diese ganze Sache sich abgespielt hat, zumal gerade in den letzten Wochen viel Falsches und Entstelltes in der Presse darüber zu lesen ist.

Zuvor jedoch einige Worte über den natürlichen Kautschuk. Die Kenntnis desselben verdankt die alte Welt der neuen Welt.

Bald nach des Columbus Fahrt wurde dieses Wunderprodukt bei uns bekannt. Wenn ich, vom alten Europa kommend, Ihnen jetzt das daselbst synthetisch aufgebaute Colloid mitbringe, so trage ich damit einen Teil der alten Schuld wieder ab, in die uns einst Amerikas Gabe versenkt hatte.

Noch vor einem Menschenalter lieferte der Süden des grossen amerikanischen Continents fast alle Handelsware. Seitdem sind in vielen tropischen Landstrichen Plantagen angelegt worden die einen ungeahnten Aufschwung genommen haben und mit ihrer grossen Produktion bald die alte Heimat des Wildkautschuks überflügeln werden. Dabei handelt es sich um Werte von vielen, vielen Millionen und für den Süden dieses Erdteils um ein überaus wichtiges und schwieriges volkswirtschaftliches Problem.

Als bekannt darf ich voraussetzen, dass Kautschuk aus dem Milchsafte zahlreicher Baum-und Strauchgattungen und grotesk geformter Lianen durch Koagulation nach verschiedenartigen Methoden gewonnen wird und dass dieses Produkt erst durch kunstgerechte Behandlung mit Schwefel oder schwefelhaltigen Verbindungen, durch sogenannte Vulkanisation, seine besonders hochgeschätzten Eigenschaften erlangt. Die Synthese ging nun ganz andere Wege. Durch Zertrümmerung des grossen Molekularkomplexes, wie er sicherlich im Kautschuk vorhanden ist, mittelst pyrogenen Abbaus, also durch Trockendestillation, wurde neben einem Rattenkönig aller möglichen Gase, Oele und Harze auch ein farbloses, benzinähnliches Liquidum erhalten, dem die Forschung den Namen Isopren gab. Der Franzose *Bouchardat* hat zuerst die Vermutung ausgesprochen, dass dieses Isopren, das bei der Trockendestillation des Kautschuks nur in ganz geringen Mengen und nur unrein gewonnen wird, zum Kautschuk in ganz besonders nahen Beziehungen stehe. Diese wichtige Frage ist dann von den Gelehrten aller Länder jahrzehntelang eifrig erörtert worden, und in diesem Meinungskampf standen sich die Ansichten pro und contra scharf gegenüber. Wohl wollte der Engländer *Tilden* durch Einwirkung von Salzsäure aus diesem Isopren schon in den 80er Jahren künstlichen Kautschuk erhalten haben. Es gelang aber weder Tilden, noch seinen Assistenten, welche sich jahrelang abmühten, den Versuch zu wiederholen. Auch zahlreiche andere Forscher darunter unsere eigenen Chemiker waren nicht in der Lage, diese Angaben zu bestätigen. Im Jahre 1894 fand Tilden, dass dasjenige Isopren, welches er 10 Jahre vorher hergestellt hatte, beim Stehen, sich teilweise zu Kautschuk polymerisirt hatte. Auf diese Weise ist Tilden der erste gewesen, welcher synthetischen Kautschuk hergestellt hat, seine Methode jedoch, welche man noch nicht wiederholen konnte, da dazu noch nicht genug Zeit verflossen ist, ist augenscheinlich technich nicht verwendbar. Erst *Fritz Hofmann* von den *Farbenfabriken vorm. Friedr. Bayer & Co.* in Elberfeld bezw. Leverkusen bei Cöln am Rhein darf als der wahre Erfinder des synthetischen Kautschuks angesprochen werden, weil es ihm im August 1909 durch Anwendung von Wärme gelang, die Isoprenmoleküle zu dem grossen Kautschukkomplex zusammen zu schmieden. Jeder ist in der Lage, diesen ausserordentlich einfachen Versuch nachzuprüfen und wird und muss die Angaben Hofmanns bestätigen vorausgesetzt, dass er reines Isopren verwendet.

Das dort in grösserer Menge ausgestellte Fabrikat ist aber auch von den bedeutendsten Fachleuten auf seine praktische Verwendbarkeit und von *Carl Harries* in Kiel, der in jahrelanger mühevoller Arbeit den Boden vorbereitete, auf seine wissenschaftliche Zusammensetzung geprüft worden.

Isopren gehört zur Familie der Butadiene. Es war begreiflich, dass dieses Betamethylbutadien keine besondere und isolierte Stellung unter seinesgleichen einnehmen konnte. Deshalb mussten auch die anderen Glieder dieser interessanten Gruppe beim Erwärmen analoge und homologe Kautschuke geben. Diese bei der künstlichen Herstellung von Naturprodukten immer auftretende Variationsmöglichkeit ist voll und ganz geglückt, und mehrere Repräsentanten der neuen Körperklasse mit anderen Eigenschaften sind dem technischen Studium zugängig gemacht worden. Exacte Beweise erbrachte auch hier zuerst Elberfeld.

Wenn Sie das jetzt alles so hören und die schönen Präparate hier vor sich sehen, so scheint das recht einfach, durchsichtig und klar. Aber dieser Schein trügt. Die Schwierigkeiten, die bisher überwunden werden mussten, waren gross, diejenigen, die noch zu überwinden sind, um ein Produkt zu machen, das dem Parakautschuk in Qualität ebenbürtig ist, und das den Konkurrenzkampf mit dem billigen, kaum 2 Mark kostenden Plantagenkautschuk aufnehmen kann, sind noch grösser. Solche Mühe schreckt den Chemiker und Techniker nicht, im Gegenteil, sie reizt ihn mächtig zu neuen Taten. Der Stein ist im Rollen, und wir werden schon dafür sorgen, dass er sein Ziel erreicht. Und was verstehen wir unter diesem Ziel? Wir hoffen, dass das synthetische Material recht bald neben dem natürlichen Pflanzengummi eine ebenbürtige Rolle auf dem Weltmarkte spielen wird. Riesenhaft ist der Konsum an Kautschukwaren. Für drei Milliarden Mark werden jährlich davon umgesetzt, und in ihnen befindet sich, zum heutigen Preise von 12 Mark gerechnet, für eine Milliarde Mark Rohgummi. Wie schrumpfen gegen dieses titanische Problem die anderen Aufgaben zusammen, die sonst dem Chemiker gestellt sind. Freilich, Phantasten wird der Lorbeer nicht zufallen, sondern nur Männern, die nüchtern und kühl ihre Schritte wägen. Solcher Ackersleute Saat reift langsam, und wenn in der Presse erwähnt wird, dass dieses alles ein Kinderspiel ist, und dass das Problem gelöst sei, so muss ich es Ihnen überlassen, ob Sie das glauben wollen oder nicht, wie so vieles, was die Druckerschwärze geduldig auf Zeitungspapier bringt. Ich stehe mitten in dieser Bewegung, schon seit langer Zeit fahren wir auf Reifen aus synthetischem Kautschuk. Trotzdem, wenn Sie mich fragen, wann werden mit dem synthetischen Produkt die so oft prophezeiten Millionen geerntet werden, so muss ich Ihnen antworten, ich weiss es nicht, sobald wohl auch nicht, obgleich sicherlich synthetischer Kautschuk in allernächster Zeit schon im Handel erscheinen wird. Aber ich hoffe es zu erleben, dass auch hier die Kunst den Sieg über die Natur davon trägt.

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Wir sind am Ende unserer Fahrt. Nicht nur über die Gefilde Deutschlands, sondern auch aller Länder, in denen chemische Industrie betrieben wird, sind wir hinweggefahren und haben Einblick genommen in das unermüdliche Vorwärtsstreben, das ruhelose Forschen nach Neuem, das nimmer ermüdende Ringen nach technischer Erkenntnis, wie es sich in den Laboratorien und Werkstätten dieser grossen und immer grösser werdenden chemischen Industrie abspielt. Unser Luftschiff führen wir jetzt dem Hafen zu, von dem aus wir unseren Aufflug genommen, und landen da, wo aus aller Herren Länder die Fachgenossen zusammengeströmt sind, um die Fortschritte, die jeder erzielt hat, den Kollegen vorzuführen und die Probleme, welche abgeschlossen sind, und die neuen, welche uns zu lösen bevorstehen, in öffentlicher und privater Unterhaltung zu besprechen.

Die internationalen Kongresse für angewandte Chemie, dienen in erster Linie diesen Zwecken und Zielen und tragen damit direkt und indirekt zur Förderung unserer Industrie bei. Sie dienen aber auch dem Nebenzweck, dass sie die grossen Taten, welche auf unseren Gebieten erzielt worden sind, in weite Kreise tragen. Dadurch machen sie die Bedeutung unserer Wissenschaft und der darauf fussenden Technik jedem klar, der in seiner Stellung, in der Gesellschaft und im Staate Einfluss hat, damit so unser Gebiet gleiche Förderung erfährt, wie andere, damit mehr und mehr bekannt wird, wie wichtig auch die chemische Industrie und damit die Träger derselben, die Chemiker, in volkswirtschaftlicher und hygienischer Beziehung sind.

Dass strahlendes Licht dieser Erkenntnis auch vom VIII. Internationalen Kongress für angewandte Chemie ausgehen wird, dafür birgt die grossartige Organisation, mit der unsere Freunde, die amerikanischen Chemiker, diesen Kongress vorbereitet haben, die geschickte Art, mit der er geleitet und durchgeführt wird, und die gastliche Aufnahme, die uns hier nicht nur von den Collegen sondern von der ganzen Bevölkerung bereitet worden ist, und die uns noch auf unseren Rundreisen durch die blühende in vieler Beziehung vorbildliche Industrie Amerikas bevorsteht.

Auch für die chemische Wissenschaft und Industrie gilt das Schillersche Wort:

"*Nur dem Ernst, den keine Mühe bleichet, rauscht der Wahrheit tief versteckter Born.*"

THE LATEST ACHIEVEMENTS AND PROBLEMS OF THE CHEMICAL INDUSTRY

Carl Duisberg, Elberfeld

(Translation supplied by the Author)

Probably in no domain of human knowledge and endeavor have the combined forces of theory and practice, intimately acting and re-acting upon each other, made such immense strides and led to the solution of such difficult problems as in the Chemical Industry, an industry which, indeed, had its beginnings in the distant past, but in its vast development and international character is essentially a child of modern times. Success has so emboldened this industry that it considers itself capable of solving any problem, provided the men in its service are well trained in theory and practice and ready to devote themselves to the best of their ability, with patience and perseverance, to the object in view. This has been shown by the struggle between the contact process of producing sulfuric acid and the old "chamber process"; by the rivalry between the Solvay process and the Le Blanc method in the manufacture of soda; by the production of nitric acid and its salts by direct oxidation of nitrogen of the air under the influence of the heat of the electric discharge; by the manufacture of ammonia from atmospheric nitrogen indirectly via calcium cyanamide, and directly by combination with hydrogen; by the replacement of madder by alizarine, and of natural by synthetic indigo, as well as by innumerable other instances in the color, perfume and pharmaceutical industries.

If, before an audience not wholly consisting of chemists, I venture, within the brief period of an hour, to describe the latest achievements of the chemical industry and to recount the problems that are engaging our attention, I must restrict myself to a great extent both in the choice of the subject matter and its mode of presentation. We can, indeed, merely touch upon the most important happenings in our industry and must, from the very outset, refrain from a thorough discussion of the subject, either from the purely chemical or the technical side. However, what cannot be described for lack of time, and what we should very much like to add for the sake of those chemists who are present, is illustrated by that rich collection of diagrams, products and materials of all kinds. What can neither be mentioned in my paper nor illustrated by these exhibits, will be demonstrated by means of lantern slides, and, should you possess patience enough, I shall show you at the conclusion of my address one of the newest factories which the German Chemical Industry has built on the Rhine, with its various manufacturing departments and, above all, its provisions for the welfare of its employees.

In the spirit of Faust: "Who brings much will bring something to many," I invite you to make a flight with me in an airship, as it were, over the fields where the Chemical Industry holds sway and, from our point of vantage, to take a bird's-eye view of the latest achievements of this industry. Now and then, we shall make a landing and examine the most attractive features a little more closely.

PRODUCTION OF POWER: The question of power, which is of the utmost importance in every industry and especially in the great synthetic processes by means of which nitric acid and ammonia are manufactured, is now dominated by the perfected utilization of hydraulic power and the development of the turbine. Not only does the transmission of electric energy render it possible to utilize water power at great distances, but it also allows of the transmission of power evolved at the coal mines and the peat fields to distant points, thus eliminating the necessity of transporting the fuel itself. Recently, we also learned to apply the principles of the water turbine to the steam turbine. But this advance over the piston steam engine, which Watt so ingeniously constructed about 150 years ago, has already been surpassed by benzine, petroleum or oil motors (Diesel motors), and, above all, by the reliable gas engines which are driven by blast furnace gases, Mond gas, and, more recently, by peat gas.

PRODUCTION OF BY-PRODUCTS: The manufacture of by-products goes hand in hand with this more direct generation of energy from fuel. These products include ammonium sulphate, of such great importance in agriculture, and the tar distillation products, so indispensable in the color industry. The latest and most rational method of utilizing the peat or turf beds, which are so plentiful in Germany and in many other countries, is practiced in Schweger Moor near Osnabrück according to a process discovered by Frank and Caro. There peat gas is produced and utilized and ammonia obtained as a by-product, the required power being generated in a 3,000 h. p. central electric power station. The moorland, after removal of the peat, is rendered serviceable for agricultural purposes.

At that place, nearly 2,500 to 2,600 cubic meters of gas with 1,000–1,300 calories of heat were obtained from 1,000 Kg. of absolutely water-free peat in the form of air-dried peat with 45 to 60 or 70 per cent. of moisture. This gas represents energy equal to 1,000 h. p. hours, equal to 700 kilowatt hours, after deducting the heat and power used for the operation of the gas works. In addition 35 Kg. ammonium sulphate were produced from the above quantity of peat which contains 1 per cent. of nitrogen.

The greatest problem of power production, the direct conversion of coal into electric energy by means of gas batteries, a problem which we had hoped to solve 25 years ago, is still today nothing more than a dream.

PRODUCTION OF COLD: Besides the problem of power and heat, the question of refrigeration is one of growing importance to the chemical industry. Instead of the ammonia machines with which a temperature of minus 20 C. can be attained, we employ today sulphurous acid machines or, better still, resort to the carbonic acid gasifier which yields a temperature of 40 C. below zero. It is hoped in the near future to produce refrigerating machines, which, by the use of suitable hydrocarbons, will give temperatures of minus 80 C. Plants for the liquefaction of air, producing as low a temperature as minus 190 C., are becoming more and more common and are especially profitable where gas mixtures, rich in oxygen, or where pure nitrogen, which are simultaneously produced, can be utilized. Diagrams showing the process invented by Linde for the rectification of liquid air with the object of isolating nitrogen and oxygen are exhibited here. The Badische Anilin and Soda Fabrik in Ludwigshafen on the Rhine intends to manufacture hydrogen from water gas in a similar way and to utilize the carbon monoxide, which is simultaneously obtained, as a source of power. In a large plant which is being erected, the firm is going to produce ammonia synthetically by combining, according to Haber's invention, pure nitrogen, obtained by the liquefaction and rectification of air, with hydrogen manufactured as above. Particulars about this process will be given during the Congress by Professor Bernthsen in his lecture on "Synthetic Ammonia."

SIZE OF APPARATUS: Influenced by the Solvay process for the manufacture of soda and its pecuniary advantages, the apparatus used in the chemical industry have enormously increased in size. In this respect the United States, no doubt on account of the example set by the iron industry with its blast furnaces with a daily capacity of 500 tons; its giant conveyers (50 ton wagons), its huge hoisting cranes, is ahead of other countries. But careful calculations have proved that there is a limit in this direction. The failure, on account of size, of the Mactear sulfate furnace, with a daily output of 25 tons, is well known, whilst the mechanical sulfate furnace of the Verein Chemischer Fabriken in Mannheim, which produces only 7 tons a day, is a success everywhere. It is not improbable that the high cost of construction and the great loss which accidental stoppage entails will necessitate a reduction in size of the wonderful Wedge furnace, a creation of the United States, which roasts 30 tons of iron pyrites per day.

In the organic chemical industry, the iron vessels for chlorination, sulfonation, nitration, reduction and oxidation, as well as the wooden tanks in which we diazotize and produce colors, have developed from the small vessels and vats of former years into apparatus of mighty size, their limit being generally determined by the capacity of the mechanical industry. But here, too, the mistakes which often occur in manufacturing processes and the extra losses which they involve, teach us that a wise moderation should be exercised.

Wherever possible, continuous operations have replaced those processes which worked intermittently. In this way loss of time and expense, caused by cooling and reheating, are avoided.

This is exemplified by Uebel's new method of the production of nitric acid from Chili saltpetre with retorts lying above each other and without stirrer, and by that of the Badische Anilin and Soda Fabrik, where the chambers are back of each other with stirrer, these methods having replaced the old single retort process.

MATERIAL: As regards the material for chemical apparatus several new wares must be referred to:

Quartz Vessels: Apart from the fact that the saltpetre industry of Norway taught us how to absorb dilute nitrous gases in towers 20 meters high, made of granite, a substance which was rarely used for chemical purposes, we have today at our disposal tubes, dishes and vessels of fused quartz, which are stable against acids and heat and which are manufactured in the same sizes and dimensions as the well-known earthen ware vessels.

Refined Steel: The greatest progress, however, has been made in the manufacture of iron alloys or refined steel.

Thanks to the kindness of Friedr. Krupp of Essen, I am in the fortunate position to describe a large number of hitherto unknown substances of great importance, of which I exhibit magnificent specimens, photographs, and lantern slides. Just here, however, I must ask you to make one of the landings from the upper air and permit me to deal with the subject at greater length. You will be astonished at the immense progress which has been made to the general benefit of our industry.

Of the greatest interest are the alloys of iron with other heavy metals and metalloids, i. e., alloyed steel.

Instead of carbon, other elements are employed, which likewise enhance the hardness of steel, but prevent the formation of a crystalline micro-structure liable to cracks and flaws. The most important of these elements is nickel.

Nickel Steel: The readiness with which nickel forms an alloy with iron has long been common knowledge. Even in Bessemer's days, attempts were made in Great Britian to turn out cannons made of steel containing 2 per cent. nickel. The experiments were not successful because the nickel obtained at that time contained impurities, such as copper, arsenic and sulphur, so that the steel could not be forged. Thirty years later pure nickel, as we know it today, made successful results possible. The same was the case with chromium, silicon and manganese, and not until these elements were produced pure, could successful alloys be manufactured with them, either alone or together with nickel. The chief aim in the manufacture of these alloys is the formation of an amorphous, pliable structure of the steel. This result is attained not only by removing more or less of carbon, but above all by a certain thermic treatment, namely, by suddenly cooling steel heated to a high temperature, heating again and keeping it at a certain lower temperature. You will see two samples of steel; in the one case, the coarse crystallization of the pure carbon steel before it is forged, and in the other, the same steel refined by the thermic treatment. The difference in the micro-structure of the forged carbon steel and that of the forged and thermically treated nickel steel must also be noted. Whilst carbon steel after forging still shows a crystalline structure with visible cleavage planes of the crystals, the section of nickel steel displays an amorphous structure closely resembling that of welded iron. For comparison sake, a sample of a welded iron fracture is exhibited. It must not be overlooked, however, that nickel and chrome nickel steels are twice or three times as hard as welded iron. There are also exhibited test pieces of construction parts to be used in the automobile industry made of alloyed steel. Notwithstanding the high tensile strength of about 90 kilos per square millimeter (i. e. about 55 tons per square inch), no fracture is noticeable although they are greatly bent.

Aside from these improvements, which are of such great moment for structural steel, the iron alloys have found many new applications.

I merely mention the different nickel alloys for ship-building, electric appliances, and for valves. These valuable alloys containing 23 per cent. and more nickel, are non-magnetic, and not affected by atmospheric influences; those containing 30 per cent. nickel possess great resistance to electricity, whilst the co-efficient of expansion of steel with 45 per cent. nickel is only one-twentieth of that of ordinary steel and not greater than that of glass.

Chromium, Tungsten, and Molybdenum Steel: It is a very interesting and novel fact that by the thermic treatment alone the micro-structure of the cheaper kinds of unalloyed iron plates and iron shapes is so changed that it becomes three times as resistant to the destructive effect of acids. If alloys of iron with chromium, tungsten, molybdenum and aluminium in certain proportions are thermically treated, this resistance is increased five-fold, as is shown by samples of ordinary carbon steel and chrome nickel steel which underwent a treatment with dilute sulfuric acid for 56 days.

An alloy of ordinary iron with 5 per cent. nickel is an excellent material for withstanding hot caustic soda. Most astonishing properties are displayed by steel alloys containing more than 10 per cent. of chromium and a small addition (2 to 5 per cent.) of molybdenum. Such alloys are manufactured in the form of malleable cast and forged iron pieces by Krupp according to the patents of Borchers and Monnartz in Aix-la-Chapelle and in the form of rolled tubes by the Mannesmann Röhrenwerken in Remscheid. These alloys are insoluble not only in dilute hydrochloric acid and sulphuric acid, but also in dilute nitric acid, even with the addition of alkali-chlorides, and if they contain about 60 per cent. chrome, 35 per cent. iron, and 2 to 3 per cent. molybdenum they withstand even boiling aqua regia. You will see samples of this extraordinary steel, after treatment with acids, compared with ordinary steel and cast iron.

Tool Steel: It must be especially mentioned that the alloys of iron with chromium, tungsten and molybdenum tempered by a special process invented by two Americans, Taylor and White, find most important uses as quick turning steel for all kinds of tools.

Vanadium Steel: The most recent improvements in the manufacture of steel for tools which must of necessity keep pace in hardness with structural steel have been made by the employment of vanadium. Unfortunately, this metal, the use of which is steadily increasing, is still very dear, and the problem which chemists have to solve is to produce it more cheaply. If the price could be reduced perceptibly, metallurgists prophesy a great future for this metal, which exercises a very favorable influence on the micro-structure of steel.

Of great importance are those alloys of iron with chromium, tungsten and vanadium which possess a high degree of hardness even at 400–500 C. They are needed by engineers for the construction of steam turbines, for the embossing and spraying of metal objects when heated to redness, a process which has lately found extensive application. Chemists use these kinds of steel whenever chemical reactions are carried out at high temperatures and pressure, e.g., for the synthesis of ammonia according to Haber's process.

The very latest alloy has now been patented and is being manufactured by Krupp for the construction of safety vaults and safes. This steel can neither be drilled nor exploded, nor can it be cut by the oxy-hydrogen flame.

Two samples of steel are exhibited, one of ordinary steel in which great holes have been cut in 5½ minutes by using an oxy-hydrogen flame and in 6 minutes by an oxy-acetylene burner, and a specimen of this new alloy which has remained intact after being treated with the same oxy-hydrogen and oxy-acetylene flames for 1½ hours. Let us hope that on this hard and infusible material the scientific safe-burglar will exercise his noble art in vain.

Manganese Steel: Of the alloys made with manganese, the manganese steel or hard steel, first produced by Robert Hadfield, because of its great wear, is chiefly used for cast iron parts of disintegrators and rails of electric tramways. On account of its hardness, this steel is not malleable, but it can be bent in the cold state and is thus very safe against breaking. It is therefore of much interest to the chemical industry where, in almost all branches, grinding operations are carried out.

Silicon Steel: Finally, I wish to refer to alloys of iron and silicon which contain 1½–2½ per cent. silicon and a high percentage of carbon. This steel is excellently adapted for tools and springs which must stand high strain. Since steel alloys containing much silicon, although brittle and porous, have proved very stable against acids, they are now being used more and more where such a property is of importance.

Alloys with about 4 per cent. silicon, but very poor in carbon, are of greater value than the above. Robert Hadfield first pointed out the importance of this alloy, whilst Krupp working, in connection with Capito and Klein, a firm of fine-plate rollers in the Rhineland, considerably improved it and introduced it for electric purposes. It is employed in large quantities in the form of sheets of 0.35 mm. (1/70 inch) thickness for the construction of dynamos, alternate-current motors and transformers. In Germany alone, the consumption of this alloy already amounts to 8,000 tons a year. This material has a resistance to electricity 4 or 5 times greater than that of ordinary iron and loses only half as many watts, so that the injurious Foucault currents are reduced to a minimum. The manufacture of transformers has therefore become much cheaper, for the proportion between iron and copper is much more economical. The production of this silicon iron alloy with its very low percentage of carbon, and that of the chrome nickel steels almost free from carbon, became possible only after silicon and chrome, entirely free from carbon, could be manufactured by electric smelting processes.

Electro-Steel: Since the electric smelting furnace has come into use in the steel industry, the problem of removing sulphur, which engaged the attention of chemists for so many years, has been solved. It has been found that the electric furnace process produces a slag free from metal, and such a slag is the prime requisite for the complete desulphuring of the steel bath.

Electrolytic Iron: Superior to the silicon steel, poor in carbon, in its electric properties is the "Ideal" metal for electromagnets —the pure electrolytic iron—first produced by Franz Fischer, of Charlottenburg, and now manufactured by the firm Langbein-Pfanhauser & Co., Leipzig. Formerly it was impossible to produce it free from hydrogen, consequently it was hard and brittle and was not malleable. Only by electrolyzing at 100–120 C. and employing an iron salt solution mixed with hygroscopic salts, such as calcium chloride, the iron became free from hydrogen. Its hardness then sinks far below that of silver and gold and is not much greater than that of aluminium. It possesses the valuable property of becoming magnetic more quickly than ordinary iron, containing carbon or silicon, and also of again losing its magnetism more readily, thus considerably increasing the efficiency of electro-motors, for which it is used. Amongst the exhibits, you will find several objects made of this electrolytic iron; for example, a cathode made from an electrolytic iron plate during 5 days of uninterrupted operation; also plates made by rolling; further a motor which, if constructed of silicon iron, would furnish 0.5 h. p., but being composed of electrolytic iron, though in use for several months without appreciable signs of wear, it now furnishes 1.3 h. p., in other words, it is 2½ times as efficient.*

With all these new materials at our disposal, among which I must also mention copper, with 10 per cent. silicon, and copper nickel, we shall surely be able to improve all sorts of chemical apparatus that suffer so much from wear and tear.

After this short invasion of the domain of metallurgy, we shall now turn our attention to the chemical industry proper, first dealing with the manufacture of inorganic substances, the heavy chemicals.

SULPHURIC ACID: The triumphal progress of the contact process for the manufacture of sulphuric acid in the United States scarcely has its parallel in Germany, where it originated. Platinum, in spite of the fact that its price has increased threefold, is still our principal contact agent. As it is possible to carry out other contact processes with various contact materials, we shall certainly find other agents than platinum available for sulphuric acid anhydride. It ought therefore to be a fruitful field for research to find cheap substitutes for platinum. The Americans in the 20 years that have elapsed since Knietsch first successfully carried out the contact process, have increased their output threefold for the same weight of platinum. Nevertheless, the old lead-chamber process still competes with the new method, and the steady improvement of this process and the purity of the resulting acid must be acknowledged. In fact, the lead-chamber process promises to make further progress in the future in view of the success of Falding's high chambers and Opls towers in which large quantities of acid flow down.

The Gaillard tower is supreme for concentration and recovery of the acid and for the regeneration of the various waste acids.

AMMONIUM SULPHATE: A new way of manufacturing sulphuric acid, together with ammonia, from the gases which are produced by the dry distillation of coal, is looming above the horizon. Burkheiser is seeking, with the aid of especially prepared wet iron compounds, to bind the sulphur, simultaneously absorbing cyan, and to convert the ammonium sulphite thus produced into ammonium sulphate by oxidation with atmospheric air.

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* See Zeitschrift für Electrochemie, No. 16, 1909.

In competition with Burkheiser, Walter Feld is endeavoring to recover sulphur directly as ammonium sulphate by a series of interesting reactions, in which thiosulphates play an important part. Such plants are in operation in Königsberg and here in New York.

NITROGEN COMPOUNDS: So much has been written concerning the progress made in the last 5 years in the utilization of atmospheric nitrogen, that I need not enter into a description of Birkeland-Eyde's, Schönherr's or Pauling's process for the direct oxidation of nitrogen by means of the electrical discharge, nor of Frank-Caro's method of forming cyanamide from carbides [The world production of cyanamide is, according to Dr. N. Caro, 120,000 tons per year, of which 31,000 tons are manufactured in Germany (16,000 in Trostberg and 15,000 in Knapsack near Cologne), 19,000 tons are made in Niagara Falls by the American Cyanamide Co., and during the next three years the total production is to be increased to 200,000 tons], nor is it necessary to describe the Serpek process for the production of ammonia from aluminium nitrides combined with the utilization of alumina which is simultaneously obtained. I will mention, however, that the problem of concentrating the dilute nitric acid, as obtained in the large absorption apparatus from nitrous gases, has been solved by Pauling's method, in which sulphuric acid is used in a battery of towers. It is also possible now to convert economically cyanamide into ammonia and this again into nitric acid.

SODA AND CHLORINE: The 50 year old Solvay process, which has conquered the whole world, still remains master of the situation. This is all the more remarkable since it is still imperfect as far as the yield is concerned, for a quarter to a third of the salt used in the process is lost as such, and the whole amount of chlorine in the form of calcium chloride.

Although the materials employed in the LeBlanc process are completely utilized, this fact will not give it any chance of surviving, and it would seem to be now chiefly of historical interest.

Not less remarkable is the 25 years' career of the alkali-chloride electrolysis. The limited market for chlorine compounds and the great space taken up by the electrolyzing baths were great obstacles to the progress of this apparently so simple method. For the same reasons the most approved processes, such as the Griesheim cement cell, the quicksilver cathodes of Castner and his successors, the Aussig Bell and the wire-gauze diaphragm of Hargreaves, with its many varieties, of which the Townsend cell is the latest and best, did not develop as expected. The limited demand also quickly restricted the operation of the brilliant method of manufacturing chlorates by electrolysis.

TIN: Tin is not only produced from natural ores, but also in more than 20 detinning establishments from tin-plate and tin-can waste; 200,000 tons of tin-plate waste are subjected to this treatment and about 24 million Marks ($6,000,000) worth of tin and iron are recovered. The electrolytic detinning process, on account of high wages, the great cost of current, and the considerable manufacturing loss, has been replaced,—where there is a market for chloride of tin,—by the patented process of Thomas Goldschmidt, of Essen. This process takes advantage of the properties of chlorine gas, in the dry state, to greedily take up tin without reacting on iron if certain temperatures are observed. Instead of the inferior quality of electrolytic tin mud, which must be converted into marketable tin by costly smelting operations, the new process yields an anhydrous tin chloride, which is used in large quantities for weighting silk. The detinning with chlorine is not carried out with cuttings, as in the electrolytic process, but with waste pressed in hard packages, so that 20 times as much material can be treated in the apparatus at the same time. In the United States this process is operated by the Goldschmidt Detinning Company of New York.

REDUCING AND OXIDIZING AGENTS: One of the most brilliant successes in applied chemistry has been achieved by the persevering experiments of some chemists with a long neglected substance, the constitution of which had never been properly understood. The old hydrosulphite of Schützenberger, rendered stable and easily transportable in powder form as an anhydrous sodium salt or as Rongalite in combination with formaldehyde, has now become a most important article of commerce. It is chiefly used in vat dyeing and for reducing purposes in general, such as stripping dyed fabrics and as Decrolin for bleaching sugar.

PEROXID OF HYDROGEN, *Persulphate and Perborates:* Peroxid of hydrogen and its derivatives at present find less favor in commerce, although their future appears to be very brilliant. Recently the Farbenfabriken vorm. Friedr. Bayer and Co. succeeded in rendering this important oxidizing agent, which easily decomposes and which can be marketed with difficulty only in watery solution, solid and stable by the addition of urea.

This powder is in the market under the name of Ortizon, but on account of its relatively high cost it is intended not so much for technical as for hygienic and pharmaceutical purposes.

The interesting manufacture of sodium peroxid from sodium and the many scientific investigations of the persalts, have not been followed by great commercial success. The persulphate and perborate, however, the latter under the name of "Persil," are being manufactured on a large scale. The reason of this failure seems to be the high cost of production.

RARE METALS: The most interesting alloys discovered by Muthmann and Auer have found little application in the arts, and the use of cerium- and thorium-preparations is still confined to the incandescent gaslight industry. Only the "Auermetal," consisting of 35 per cent. iron and 65 per cent. cerium, is employed and this only to a limited extent for the manufacture of pocket cigar lighters.

In the metal filament lamp industry, tungsten, which shows the highest melting point of all metals, namely 3100°, has replaced tantalum, which melts at about 2300°. This became possible only after successful experiments to render the metal ductile by hammering.

The elements cadmium, selenium and tellurium are obtained in great quantities as by-products; the first is produced in the zinc industry, the other two from the Tellur gold ores which are found in Cripple Creek, Colorado. Although they are sold at relatively low prices they find but little use in the industries.

ARTIFICIAL PRECIOUS STONES: Finally, I will, in but a few words, touch upon a new industry, viz., the synthetic manufacture of precious stones from alumina with additions of chrome oxide, iron oxide or titanic acid. Artificial rubies and white, yellow and blue sapphires, which cannot be distinguished from natural stones, are being manufactured in great quantities in Paris and recently also by the Electrochemische Werke, Bitterfeld. They are used extensively for jewelry and especially as bearings in watches and measuring instruments.

All this will give you a striking picture of the development of inorganic chemistry which is taking a more and more important position beside organic chemistry.

APPLIED ORGANIC CHEMISTRY: In the organic chemical industry the reactions are considerably more complicated and the apparatus mostly smaller than in the inorganic industry. Here the chemist, like a juggler with his balls, gives every atom a definite position in the many thousand combinations which carbon forms with hydrogen, oxygen, nitrogen and sulphur, and there exist the most varied reactions and processes which may lead to the same result. This chemistry of the carbon compounds has been most wonderfully perfected in the coal-tar color industry, and in every factory of this branch there are hundreds of scientifically trained chemists always experimenting and daily finding new combinations possessing properties of technical value. Before these products become finished articles to be sold as colors, perfumes or pharmaceutical preparations, they must further go through a series of numerous intermediary operations, which finally lead to the marketable chemicals.

COAL-TAR: The starting material of the important coal-tar color industry is the black tar which is obtained by the dry distillation of coal and is known to contain about 150 different chemical products, of which, aside from carbolic acid, the aromatic hydrocarbons, benzole and its homologues, toluol and xylol, naphtalene and anthracene, play the greatest part.

More recently carbazol has been isolated from tar on a large scale and has become a most important raw material for the manufacture of the color "Hydronblue" by Leopold Cassella and Co., Frankfort o/M. Hydronblue is a sulphur dyestuff distinguished by its fastness against washing and chlorine. Acenaphthen, which also occurs in coal-tar as such, is the starting material of a red vat dye "Cibanonred," discovered by the Society of Chemical Industry in Basle. It is to be regretted that hitherto no technical use has been found for phenanthrene, which is also one of the constituents of tar.

Besides carbolic acid, its homologues, the various cresols, etc. are being isolated by Dr. F. Raschig in Ludwigshafen on the Rhine. These substances are largely employed in the manufacture of explosives and coloring matters.

As long as coal gas is produced for illuminating and heating purposes and as long as coke must be used for the reduction of iron ores, tar will always remain the cheapest raw material for the manufacture of these hydrocarbons. But since it may become necessary in the future—as is already possible today—to use coal in a more rational way, at the same time producing hydrocarbons, the coal-tar color industry need not fear a scarcity of this important raw material, the less so as certain kinds of petroleum, e. g., Borneo petroleum, contain large quantities of aromatic hydrocarbons from which the Rheinische Benzinwerke, in Reisholz near Düsseldorf, has already isolated toluene in the form of nitro-toluene in a commercial way. If, however, a still greater demand for these hydrocarbons should occur, other methods of obtaining them must be found. We shall then surely succeed in producing them synthetically either directly from the elements carbon and hydrogen or indirectly from carbide of calcium by passing acetylene through glowing tubes—a reaction which was already carried out successfully in the early sixties of the last century by Berthelot and recently by Richard Meyer. At the present time about one-quarter of Germany's annual output of coal is converted into coke, viz. 20 per cent. for foundry purposes and 4 per cent. in gas works, whilst in England the quantities are 12 per cent. and 6 per cent. respectively.

DISTILLATION OF TAR: The point of greatest importance in the distillation of tar is still the separation and isolation, in the cheapest possible way, of the different hydrocarbons in their purest form. The stills have been continually enlarged, those employed to-day having a capacity of 60,000–80,000 litres (13,000 –17,500 gallons). On the other hand, a continuous process, such as is possible in the bituminous coal-tar industry, has not yet been found. A large number of patents have been taken out for apparatus intended to solve this problem, but none of them have proved satisfactory in practice.

ORGANIC INTERMEDIATE PRODUCTS: The conversion of the aromatic hydrocarbons into intermediate products necessary for the color industry is almost always carried out by treatment with concentrated sulphuric and nitric acid and subsequent reduction of the thus obtained nitro-compound by means of metals, metalous oxids and metal sulphides. In the production of amines, iron is the principal agent of reduction, while zinc and tin are mostly used in the production of azo-compounds. The electrolytic reduction has not proved useful for these processes.

The methods of producing nitro- and amido-compounds have been very little changed as far as chemical operations are concerned, but with the increase of their production their poisonous properties became more and more apparent and forced the manufacturer to modify the processes so that they could be carried out in tightly closed vessels in order to protect the life and health of the workmen.

In Germany legislation has been recently enacted, based on the experience of the individual factories, which lays down rules and regulations for strict observance.

Several trinitro-compounds have been shown to be good explosives, and, like trinitrotoluene, are now largely employed as substitutes of picric acid in the manufacture of explosives.

The introduction of oxy-groups into the molecule is mostly brought about by melting sulpho acids with alkalies, and, according to more recent methods, with alkaline earthmetals, such as calcium- and barium-hydrate. Since chlorine, produced electrolytically, is obtainable in unlimited quantities and chemically pure, chlorine substitution derivatives of the hydrocarbons have been employed for all kinds of synthetical purposes. Many of these chlorine derivatives can not only be converted into oxy-derivatives by melting with alkalies, but, like paranitro-chlorbenzole, they also directly exchange their chlorine for an amido group when treated with ammonia or its derivatives. Colors also often change their shade when a halogen atom is introduced into their molecule and acquire more valuable properties. Chlorine has therefore proved exceedingly useful in the preparation of intermediate products and will undoubtedly become of still greater service in the future.

In the naphtaline series, the method discovered by Bucherer and Lepetit for the conversion of the hydroxyl group into the amido group and vice versa, employing sulphurous acid esters, has proved of great practical value. Phosgene, too, is, to-day, being more and more employed. Several decades ago it became an important substance for the production of the urea of para-amidobenzolazo-salicylic acid, introduced into the market, under the name of "Cottonyellow," as a beautiful yellow cotton color of great fastness to light. It's principal use, however, was for the manufacture of the bright but fugitive triphenylmethane colors. It is now especially used to combine 2 molecules of aromatic compounds with free amido groups, thus producing urea derivatives, and if the starting material is an azo color, the resulting urea derivative is, as a rule, much faster to light than the original color. Imidazol, thiazol and azimido compounds of the most varied kinds are also manufactured and converted into azo colors.

In the series of the aldehydes and carboxylic acids there are no epoch-making discoveries to be recorded. Chemists still start from hydrocarbons chlorinated in the sidechain or directly oxidize the homologues of benzole. Kolbe's synthesis of salicylic acid, of which large quantities are used in the color industry, is also applied at an ever-increasing rate for the production of the oxycarboxylic acids. But the direct introduction of the carboxylic group into the benzole molecule, unsubstituted by hydroxyl, is a greatly desired achievement which, however, has not yet been attained. It is also a matter of greatest importance that in substitution reactions of the aromatic nucleus we should be able to vary at will the ratio of the isomers to be formed.

Besides the biochemical production of ethylic alcohol from wood waste and from the waste liquors of the sulphite cellulose industry, I wish to mention the synthesis of organic compounds by the addition of water to acetylene. In this manner we produce in a simple way acetaldehyde, which can be easily converted into acetic acid, a very important starting material for the manufacture of numerous products.

The steady search for new raw materials and new intermediate products to be utilized in the manufacture of colors has often been crowned with success. We need only to recall the many intermediate products which have been made available for the production of the vat dyes and sulphur colors and which have led to the discovery of new substances with most valuable properties. Very often new lines of research are not always based upon preconceived theoretical ideas, but are opened up by mere accident. A keen power of observation, however, is the most necessary equipment of the chemist who aims at success.

COAL-TAR COLORS: In no branch of technical chemistry has such intense work been performed as in that of the coal-tar color industry. The outsider long ago may have thought that so much had been accomplished in this field that nothing more was left to be done. The countless dyestuffs, giving all the colors of the rainbow, might well have given rise to the belief that there was already a surplus. But here the course of events was just as it generally is in life. With growing possessions, man's needs and demands also multiply. While people were formerly content to produce with coal-tar colors every possible shade in undreamt-of brightness in the simplest way, they gradually began to make more and more exacting demands as regards fastness. Not only had materials to be dyed a pleasing shade, but they also had to be fast to washing and light. Thus new, alluring problems were submitted to the color-chemist, and his indefatigable efforts have already carried him a long way towards the desired end. Strange to say, amongst the public, you will frequently meet the view that artificial colors do not give fast dyeings. This is a decided error which cannot be too emphatically contradicted. Today we can produce almost any shade with any desired degree of fastness on any kind of material, whether it be wool, cotton, silk or paper. If the dyer does not always produce such shades it is the fault of the trade which does not express its demands forcibly enough. Of course, the dyeing with fast colors entails a somewhat greater expense which must naturally be borne by the consumer.

Just at this point, before discussing the progress made in the manufacture of fast colors and in order to prevent misunderstanding, I should like to emphasize the fact that the old colors, though not as fast as those more recently discovered and though, perhaps, quite fugitive in some respects, still have a right to exist. It would be quite foolish to dye certain kinds of paper intended to be in use for only a very short time, with colors absolutely fast to light, or to dye cloth never to be washed, with expensive colors fast to washing, or, again, to treat lining, which is but slightly exposed to sunlight, in the same way as materials which must be exceedingly fast to light. Everything according to reason. For many purposes, however, the need for shades fast to light or to both light and washing is so great that it must be given every consideration. How mortifying it must be to notice shortly after you have decorated the walls of your home with most beautiful and expensive materials, that the lovely colors daily grow more unsightly, and to see a solitary patch showing up in all its pristine glory amidst a faded background when a picture or other piece of furniture is moved to another place. As it is possible to guard ourselves against such occurrences, we should certainly do so. Today we are able to produce the most beautiful colored wall-coverings, whether of paper or of woven or printed fabrics, to meet every requirement in regard to fastness. This is proved by the large collection of all kinds of woolen and cotton fabrics (after washing and exposure to light) and especially of wall-papers, of carpets, rubber material and balloon coverings, which the different firms of the German color and dyeing industry have placed at my disposal for exhibition.

If you now inquire how chemists have been able to make such great progress, my only answer is by logical and untiring efforts along well-known ways, undaunted by failures, and by diligently following any track, however faint, that gave promise of advance

In every branch of the color industry these methods have led to faster and ever faster dyestuffs, from the multicolored benzidine colors, described as fugitive to light and not stable to washing, to the anthraquinone colors and the indigoid vat dyes. In all these classes we have gradually learned to recognize certain regularities and to accomplish certain results by systematically grouping the components and fixing the position of the substituting groups, and thus we have succeeded in increasing the fastness to light of the individual chemical according to a preconceived plan.

INDIGOID COLORS: The synthetic production of colors allied to indigo was stimulated by the successful synthesis of indigo which almost entirely displaced natural indigo and called the attention of both chemist and consumer in an increased measure to the advantages of vat-dyeing. The King of Dyestuffs, Indigo, now finds itself in the company of a whole series of other colors, the brome indigos, the thio indigos and alizarine indigos, the shades ranging from blue to red, violet, grey and black. Even the "purple" of the ancients has been reproduced by Paul Friedlaender, who by isolating the dyeing principle found in certain glands of the purple snail living in the Mediterranean, has demonstrated the fact that this natural color is identical with a dibromindigo which had been long before produced synthetically. These indigoid colors possess the same, if not better properties as indigo itself.

ALIZARINE COLORS: The fastness of the alizarine colors, e.g. alizarine red, used for Turkey red, was well known in ancient times. But, whereas formerly only mordant colors were considered to be fast, and consequently only these were looked for in the anthraquinone group, which led to the discovery of alizarine-orange, -brown, -blue and the alizarinecyanines, Robert E. Schmidt, in 1894 to 1897, succeeded in finding acid-dyeing anthraquinone colors which dye every shade, rivalling the old and well-known triphenylmethanes in brightness and simplicity of application and the alizarine mordant colors in their extraordinary fastness to light. I merely mention alizarine cyanine-green, alizarine-sky-blue, anthraquinone-blue, alizarine-sapphirole, -astrol, -irisol and -rubinol. Their fastness to light is so excellent that in the famous "Manufacture Nationale du gobelins" in Paris, they have replaced the older dyestuffs for the dyeing of wool used in the manufacture of gobelins. This means a great deal if it be borne in mind that a square meter of these gobelins for the production of which an operator needs more than a year, costs, on the average, about 6,000 francs.

INDANTHRENE AND ALGOLE COLORS: An entirely new era began for the alizarine series when Réné Bohn in 1901, found that his new color, indanthrene, could be used as a vat-dye for cotton. This color can be dyed in its reduced state like indigo, but is far superior to the latter in beauty and brightness of shade, as well as in fastness to washing and light. Indeed, the fastness to light is so great that in this respect it must be termed indestructible.

On account of this phenomenal fastness, indanthrene blue caused chemists to look for other vat colors in the anthraquinone series. Their efforts did not remain unrewarded, and we already possess colors of this class giving every possible shade. The Badische Anilin and Soda Fabrik sell them under the name of "Indanthrene Colors," the Farbenfabriken vorm Friedr. Bayer and Co. under the name "Algole Colors." Chemically most of these vat colors belong to the indanthrene type; some of them are still more complicated nuclear products of condensation of several anthraquinone molecules; others, again, rea di- and tri- anthraquinonylamines. It must also be noted that to the greatest surprise of all experts in this branch, it was discovered in the laboratory of the Farbenfabriken vorm. Friedr. Bayer and Co., that even some of the simplest acyl derivatives (-benzoyl) of the aminoanthraquinones are excellent vat colors.

LAKE COLORS: We must not leave out of sight the importance of some colors of the aniline group and especially the anthraquinone group for the production of lakes for paints and pigment colors for wallpaper. The alumina lake of alizarine, the so-called madder lake, with its fine shade and great fastness to light, is best known. Other alizarine colors also yield valuable alumina lakes; thus, alizarine sapphirole gives a blue lake of excellent fastness to light. But it is not always necessary to precipitate lakes. Some of the difficultly soluble vat colors may be directly employed in a finely-divided form. Thus indanthrene and algole blue already play important roles as substitutes for ultra-marine for bluing higher class paper, textiles and even sugar.

The development of the anthracene colors, aside from the tinctorial progress, brought about remarkable results in pure chemical research, for example the peculiar action of boric acid and the catalytic action of quicksilver in the sulphonation processes of anthraquinone.

But in this branch of our science as well there is still much room for development. Many problems remain unsolved and new ones are continually arising. To satisfy the demand of the dyer many dyestuffs must still be synthetized.

The ceaseless efforts of the color chemist will undoubtedly bring us farther and farther along this road, and complaints about the insufficient fastness of dyed materials will be silenced at last. If this goal is to be reached, it is absolutely necessary for the consumer to support the manufacturer, and I take this opportunity to state that in the United States of America these fast colors are today more generally used and found recognition and widespread application here earlier than in any other country.

PHARMACEUTICAL CHEMISTRY: I will now deal with the progress and problems of the pharmaceutical industry in the synthetic production of medicinal drugs. This industry is the youngest daughter of the coal-tar industry and it is not long since she celebrated her 25th anniversary. Those, who, like myself, had the good fortune to stand at her cradle when Ludwig Knorr discovered antipyrin, and to guide her first tottering steps at the time phenacetin and sulfonal were brought out, must look back with a joyful heart to this period of splendid growth. Much brilliant work has been accomplished but a vast amount still remains to be done. Here we see chemistry and medicine intimately bound together, the one dependent upon the other and powerless without its aid. What an organization, what boundless intelligence is necessary and what immense energy has to be expended in order to discover a new synthetic remedy and to smooth its path through the obstacles of commerce! First, we need a fully-equipped chemical laboratory, then a pharmacological institute with a staff of men trained in medicine and chemistry, an abundance of animals to experiment upon, and finally—the latest development in this field—a chemo-therapeutic and bacteriological department equipped according to the ideas of Professor Ehrlich; these in close connection with one another. Whatever has been evolved, and after much painstaking effort selected as useful, finds its way into the manufacturing department, there to be elaborated in the most minute details and brought to the highest possible pitch of perfection. Now begins the arduous work of the scientific department! Here the right sponsors must be found, here all prejudices must be brushed aside and an extensive propaganda initiated. Next, a host of clinicians and practitioners must be called into requisition so that what has been evolved in the silent workshop will be conducted on a staunch ship into the wide sea of publicity. And, finally it is the calculating salesman's turn; he must bring in enough to cover all the expenses of the innumerable experiments that have been made, if the new drug, which has swallowed so much money, is to survive and prosper. Truly, all this is a task which only too often is misunderstood and insufficiently appreciated. If, however, a great hit is made—an event almost as rare as the Greek calends —then the envious, the patent- and trademark-violator, and even the smuggler, cling to our heels and seek to rob us of our profits which, taking everything into consideration, are really not large. But despite all this, and though unfortunately opposed by druggists and physicians even today, the pharmaceutical industry serenely pursues it's task. For besides certain economic aims, we also have ideals to strive for. We combat systematically the symptoms of disease and are the faithful auxiliaries both of the doctor and the harassed nurse. The agonizing pains of the patient we allay with narcotics and anesthetics. When sleep flees the couch of suffering, we compel it to return; fever, we banish. We destroy the minute organisms which cause and spread diseases. Thus we add to the store of what is valuable, and perfect what already exists. We also isolate the active principles of various drugs and thus assure exact dosage and freedom from undesirable or even dangerous by-effects.

In the chemical works of Germany pure chemical science receives its due. In every branch of inorganic, organic and physiological-biological chemistry we are working with an army of scientifically trained men. In synthetic chemistry, brilliant achievements have fallen to our share. Quite recently, Stolz succeeded in building up adrenalin,* Decker in making hydrastinin and Emil Fischer and Wilhelm Traube in producing purin bases. All of these are magnificent accomplishments, and many of them have been effected in the laboratories of the industry.

That even yet, as at the beginning—the antifebrin period—we must trust to chance is shown by the discovery of atophan, the latest valuable antiarthritic, which is due to a fortunate accidental observation. In the subject of the old ergot problem, research work is gradually bringing more light and makes the possibility of synthetically producing a substitute a thing of the near future. The Publications on this subject show that hemostatic alkaloids possess a comparatively simple constitution. That sedatives have their place in an age when nervous disorders are so common is not to be wondered at. I need merely remind you of the new adalin which has proved exceedingly useful. Recently, Emil Fischer, the master of chemical research, to whom the pharmaceutical industry is indebted for the synthetic purin bases, viz. caffein, theobromine, and theocin, as well as the valued remedies, veronal and sajodin, has succeeded, after long and fruitless labors, in elucidating the constitution of tannin and producing it synthetically. He has thus proved that it might be possible to manufacture tanning agents of all kinds artificially and has opened up a new and promising field for research.

Chemotherapy: But a short while ago, Ehrlich drew attention to another promising branch of pharmaceutical-medical chemistry, viz. the treatment of infectious diseases by chemical means. After many years' arduous labor and after many thousand experiments on different animals this master of medicine and chemistry succeeded in demonstrating that it is possible to produce chemical substances which will kill the parasites in the human body without injuring their host and that this action is a function of the chemical constitution. The new science, with its magical bullets directed only against the injurious organisms in the body, but not affecting its cells, pursued its course from aminophenyl-arsinic acid (atoxyl) to diamino-oxyarsenobenzole (salvarsan). Thus a new synthetic preparation, an arsenic compound, is added to the old and highly effective remedies, mercury, quinine and salicylic acid. It is certain that we are here only at the beginning of a new development. We know already that we are able to combat not only spirochetes but also bacterial diseases, like tuberculosis. Even carcinoma and sarcoma, those growths so destructive to humanity whose cause is, however, not yet understood, can probably be influenced in a like manner by means of selenium compounds, as first pointed out by Emil Fischer. But were we to learn to cure diseases due to trypanosomes and plasmodia, what a great work we should have accomplished in the interest of humanity and social economy, for it is in the most fruitful lands indeed that these diseases, malaria and sleeping sickness, are to be found, and man and beast are ruthlessly destroyed by them. Neither salvarsan nor atoxyl are of service here, and therefore other hitherto unknown remedies must be found.

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* 1 kg. adrenalin, which is now prepared synthetically, and has been introduced under the name of "supreranin" by the Farbwerke of Hoechst, requires for its production the adrenal glands of 40,000 oxen. This product, as well as numerous other glandular preparations, is nowadays manufactured by the large American slaughter houses themselves.

While the treatment of syphilis, with its terrible consequences, is still imperfect in spite of mercury and salvarsan, let us hope that the systematic experiments carried out in the laboratory with the innumerable products which chemistry is able to produce from mercury and from arsenic will finally lead to complete success.

SYNTHETIC PERFUMES: In the perfume industry the developments made since the scent of the violet was imitated with jonon, and since the successful synthesis of camphor from turpentine, are not of such nature that we need to deal with them at great length. The importance of this industry appears from its yearly turnover of 45–50 million Marks (10 to 12 million dollars). Here the efforts of the chemists are directed towards determining the constitution of the complex and simple natural perfumes, isolating the various products of decomposition obtained during the investigation, and finally reproducing the natural perfumes synthetically. Such results have already been achieved in the case of the odor of the rose, lily-of-the-valley and violet. Very often certain substances are needed in the compounding of perfumes which like indole possess anything but a pleasant smell.

Artificial Silk: Even if doubt be expressed as to whether artificial silk (the yearly consumption of which amounts to about 7 million kilograms) still belongs to the chemical industry because it stands in such close relation to the textile industry, with its weaving and spinning machines, yet the raw materials needed for its production, such as nitro-cellulose, copper ammonia cellulose and cellulose-xantogenate are of such importance that the chemist and engineer equally divide the responsibility in this branch of manufacture. Viscose silk from xantogenate of cellulose, the production of which has been recently very much improved, seems to replace nitro-cellulose silk and the copper ammonia silk. This viscose silk surpasses all other artificial silks in lustre and is the cheapest to manufacture, so that the apparently simplest process of all, the copper ammonia cellulose silk, cannot compete with it any more. Among the exhibits are fine specimens of this silk from the Vereinigten Glanzstofffabriken of Elberfeld and their factory in Oberbruch in Dremmen near Aix-la-Chapelle, including the various raw materials, wood, cellulose, alkali cellulose and the cellulose-xantogenates produced by treatment with bisulphide of carbon and the viscose solution itself.

Acetylcellulose. *Cellit Films*: From acetylcellulose soluble in aceton, called cellit, the Farbenfabriken vorm. Friedr. Bayer and Co. first produced cinematograph films, but although they have the great advantage over those manufactured from nitro-cellulose in being non-inflammable, it has not been possible to introduce them generally. In all their properties the cellit films are equal to the old inflammable ones, yet the proprietors of moving picture theatres do not take them up because they fear the competition of the schools and the home where the cellit films would be largely used on account of their non-inflammability. The only help then would be such action by those in authority as to make it difficult to employ inflammable films and to facilitate the use of cellit films. There are prospects of such legislation at least in Germany, which would put an end to cinematograph fires with their great danger to life and property.

NON-INFLAMMABLE CELLULOID (Cellon): The problem of manufacturing non-inflammable celluloid by mixing cellit with suitable camphor substitutes which burn difficultly or not at all may be considered as definitely solved. Eichengrün has simplified the manufacture to an extraordinary extent by showing that certain acetylcelluloses may be gelatinized in the same way as nitrocellulose. As is well known, nitrocellulose with camphor in the presence of a solvent yields a so-called "Solid solution," and even in the dried state may be easily cut or formed into sticks, tubes or threads. Cellit when treated in exactly the same way with appropriate camphor substitutes, can be converted into "cellon," the non-inflammable substitute for celluloid. Single blocks weighing 200 lbs. are already produced on a large scale which like celluloid, can be sawed, cut, and polished; when heated can be pressed or bent; and when subjected to steam at a high temperature can be drawn and molded. Compared with celluloid, cellon has the advantage of being more elastic, soft and ductile. It is therefore frequently used as a substitute for hard rubber, gutta percha, leather, etc. Cellon, in the form of a highly viscous, syrup-like solution, may be employed for coating fabrics, wood, paper, metal, etc., with a thick, enamel-like uniform and pliable surface. Thus patent leather, artificial leather, insulators, balloon covers, etc., may be produced. In France this varnish is already employed for enamelling aeroplanes. Objects made of this novel and widely useful material are to be found among the exhibits, being manufactured by the Rheinisch-Westfälische Sprengstoff Actien Gesellschaft in Cologne and the Société Industrielle de Celluloid in Paris.

RUBBER: Finally, I will refer to one of the greatest successes and yet one of the most difficult problems of the chemical industry, viz; the production of synthetic rubber. I am proud of the fact that its production was successfully accomplished in the works which are under my management, and that I was able to follow every stage of this important discovery. Perhaps you would be interested to hear, although it is getting late, how the whole thing happened, especially as much that is untrue and misleading has appeared in the press during the last few weeks.

But first a few words about natural rubber. The old world owes its knowledge of this substance to the new. This wonderful product became known in Europe shortly after Columbus discovered America. If I, coming from across the ocean, now bring you this colloid prepared there synthetically, I merely repay part of the debt which we owe America.

Hardly a generation ago, the southern part of this great American continent furnished the whole supply of the different kinds of rubber. Since then extensive plantations of rubber trees have been established in various tropical countries and their yield has grown so enormously that the old home of wild rubber will soon be thrust into the background. This is a matter which involves many millions; consequently a very serious economical problem confronts South America.

You all know that caoutchouc is made from the milky sap of numerous species of trees and shrubs and the grotesquely formed lianas by various coagulation processes, and that this product, on being suitably treated with sulphur or sulphur compounds, i.e. by vulcanization, acquires its valuable and characteristic properties. The synthetic method took quite a different route. By breaking up the very complex molecule which rubber doubtless possesses, by pyrogenetic processes, i.e., by dry distillation, a veritable maze of all kinds of gases, oils and resins was obtained, as well as a colorless fluid resembling benzine, to which the investigators gave the name "Isoprene." It was Bouchardat who first expressed the belief that this isoprene, which is obtained in very small quantities and in an impure form by the dry distillation of caoutchouc, might be closely and intimately related to caoutchouc itself. This important question was then eagerly discussed for several decades by the scientists of all countries and opinions were sharply divided.

As far back as the Eighties, Tilden claimed to have prepared artificial rubber from isoprene by treatment with hydrochloric acid and nitrous acid. But neither Tilden nor his assistants, though they worked strenuously for years, succeeded in repeating the experiments. Moreover, numerous other investigators, among them our chemists, were unable to confirm the results. In 1894 Tilden found however, that that isoprene which he had prepared about ten years before, on standing, had partially polymerized into rubber. In this way Tilden in fact was the first discoverer of synthetic rubber. But this method which time has not yet permitted to repeat, is obviously not a commercial one. Dr. Fritz Hofmann of the Farbenfabriken vorm. Friedr. Bayer & Co. is to be regarded as the real inventor of synthetic rubber, for, by the application of heat, he succeeded as the first in August, 1909, in polymerizing the isoprene molecules completely into the complex rubber molecule on a technical scale. Somewhat later Harries invented independently another method of arriving at the same result. Everyone is now in a position to repeat this exceedingly simple experiment himself, but in order to confirm Hofmann's results, it is necessary to employ *pure* isoprene.

The practical value of this rubber, of which many samples are among the exhibits, has been tested by the highest authorities in this branch of the industry, whilst Professor Karl Harries, whose unremitting labors extending over many years, prepared the soil for Hofmann's synthesis, has carefully examined the chemical constitution of the substance.

Isoprene belongs to the butadienes. It was therefore to be assumed at the start that betamethylbutadiene would not hold a peculiar and isolated position amongst the butadienes in general. It was argued that other members of this interesting group of hydrocarbons would yield analogous and homologous rubbers on being heated. In the synthesis of products occurring in nature, there is always a possibility of producing such variations, and our endeavors to find out whether this was true in the case of rubber were crowned with success, for today several representatives of the new class of caoutchoucs possessing different properties are known and are being submitted to technical tests. Exact proof of the existence of the class of isomeric and homologous caoutchoucs was also first presented by Elberfeld.

To you who hear this account and see these beautiful specimens, the matter appears very simple, intelligible and clear. In reality, however, it was not so. The difficulties which have been overcome were great indeed and those which still remain to be surmounted, in order to produce a substance equal to para caoutchouc in quality and capable of competing with cheap plantation rubber costing only 2 marks per kilo, are still greater. But such difficulties do not intimidate the chemist and manufacturer; on the contrary, they spur them on to further efforts. The stone is rolling, and we will see to it that it reaches its destination. The end in view is this: that artificial rubber may soon play as important a role in the markets of the world as does natural rubber. The consumption of rubber is simply enormous. Finished articles to the value of 3 milliard marks are manufactured every year, and the raw material from which they are made, calculated at the present market price of 12 marks per kilo, costs one milliard marks. Other tasks which the chemist has on hand shrink into insignificance compared with this gigantic problem. The laurel wreath will not adorn the brow of the wild dreamer but that of the scientist who, cool and persevering, pursues his way. The seed he sows ripens slowly, and though according to the statements in the press, all this is mere child's play and the problem has been solved, I leave it to your judgment whether this is true or not, like much that printer's ink patiently transfers to paper. I am right in the midst of this excitement. I have employed articles made of synthetic rubber, and for some time I have used automobile tires made of this material. Yet, if you ask me to answer you honestly and truly when synthetic rubber will bring the millions which prophets see in its exploitation, I must reply that I do not know. Surely not in the immediate future, although synthetic rubber will certainly appear on the market in a very short time. But I hope to live long enough to see Art triumph also here over Nature.

We are now at the end of our journey. We have flown not only over the field of Germany, but also over all other countries where the chemical industry is cultivated. We have taken a passing glance at the untiring striving for advance, the restless search for the hidden and unknown, the ceaseless efforts to acquire more technical knowledge as witnessed in the great laboratories and factories of our mighty and ever-growing industry. We will now guide our airship into the haven whence we set out and land where our co-workers have gathered from all the countries of the earth to recount whatever progress each has achieved, and to discuss, in public and private, the problems which have been solved and those which still await solution.

This is the purpose and aim of the Congresses of Applied Chemistry, and in this way they promote directly and indirectly the interests of our industry. But they also serve another purpose —to spread far and wide knowledge of our great deeds. It is thus that they impress the importance of our science and the arts founded on it upon the public in general and especially upon those who have influence in social or official positions, so that our profession may advance equally with others, and so that the importance of the chemical industry and of those connected with it from an economic, hygienic and social standpoint may become better and better known.

That the effulgent light of this knowledge will also be diffused by the Eighth International Congress of Applied Chemistry is assured by the magnificent organization which our friends, the American Chemists, have provided, the skillful manner in which the affair has been conducted, the hospitable reception which has been extended to us, not only by our colleagues but by the people at large, and which is still awaiting us in our tours of inspection of the flourishing industry of America, in so many respects a model for others. For Chemical Science and the Chemical Industry the following words of Schiller are beautifully descriptive:

"Only the serious mind, undaunted by obstacles, can hear the murmuring of the hidden spring of Truth."

In moving a vote of thanks to Geheimrat Duisberg Professor Leon Lindet said:

Mesdames, Messieurs:

J'ai reçu, du Comité international des anciens présidents, l'agréable mission de remercier au nom de tous, M. le docteur Duisberg, de la magistrate conférence que nous venons d'entendre. Il a passé en revue tous les progrès que l'industrie chimique a réalisés depuis trois ans à peine, et pour que ces magnifiques

découvertes la gravent mieux dans notre mémoire, il a pris soin de rassembler une admirable collection de tous les produits dont il nous a parlé.

Je me rappelle l'emotion qui s'est produite au moment où nous avons connu les premières synthèses de l'alizarine, de la vanilline, etc. Qu'est-ce cela, quand on jette les yeux sur les collections qui sont devant vous? On se serait estimé heureux de penser qu'un jour on pourrait reproduire artificiellement une grande partie des produits naturels; on fait mieux aujourd'hui, puisque nos chimistes sont parvenus à fabriquer des couleurs, des odeurs, des substances médicamenteuses que la nature a toujours été incapable de nous préparer.

Devant ces résultats que le Dr. Duisberg vient de nous faire connaitre, je vous demande de lui prodiguer vos applaudissements. Mais vous applaudirez aussi cette admirable cohorte de chimistes, à quelle que nation qu'ils appartiennent, qui ont consacré leurs efforts, dépensé leurs énergies pour le bénéfice de l'Humanite.

Mr. Arthur D. Little, in seconding Professor Lindet's motion said:

Dr. Duisberg's masterly exposition of the splendid results achieved by the combination of German chemistry, German enterprise and German capital, has been a delight and revelation to us all. We have in this country the capital, the enterprise, and I fully believe, the chemistry as well, required for equally great industrial achievements. That we cannot thus far point to them is due to the fact that with us chemistry is too often left like Cinderella sitting beside the ashes of the laboratory furnace, while her two haughty sisters drive away together to the industrial ball. But some day, not far distant, her prince will come and lead her forth to take her proper place before the world. Some of us indeed suspect that he is even now amongst us incognito, registered at the Hotel Belmont under a name which looks like "Nichols." Whether that is true or not, and by whatever name he may ultimately disclose himself, we may be sure that in all the essentials which make for initiative and character he will resemble Dr. Duisberg. He will be endowed with the same far-sighted imagination, the same energy, the same courage

and the same tenacity. He will be wise in that chemistry which deals with men as well as learned in the chemistry which deals with things. He will be a Doctor of Chemical Organization, and we must not be surprised if his degree reads C.O.D.

It is with a sincere appreciation of our obligation to Dr. Duisberg for the inspiration of his lecture and his personality that I take pleasure in seconding, upon behalf of more than 6,000 American chemists whom I have the honor to represent, this motion for a vote of thanks.

The motion was carried unanimously amid great applause.

GENERAL LECTURE, TUESDAY, SEPTEMBER 10, 1912

Program of Organ Recital

PROFESSOR SAMUEL A. BALDWIN, *Organist*

1 Concert Overture in C Major............*Alfred Collins*
2 Soutenir..........................*Edwin C. Lemare*
3 Carillon...........................*William Faulkes*
(dedicated to Mr. Baldwin)
4 Bacarolle in B flat...................*William Faulkes*
5 March—"Pomp and Circumstance".....*Edward Elgar*

ADDRESS OF WILLIAM HENRY PERKIN, MANCHESTER.

THE PERMANENT FIREPROOFING OF COTTON GOODS

When I had the honour of being asked to deliver one of the General Lectures, I had no choice but to accept and yet it was at once evident to me that I should experience very great difficulty in finding a subject suitable to this occasion and interesting to the brilliant and distinguished audience which I see before me this afternoon.

This difficulty is due to the fact that, while I have always taken an interest in industrial questions and have repeatedly investigated industrial problems from the scientific point of view, my researches have, for the most part, lain in the path of pure Science, and any practical application of my researches to the Chemical and Allied Industries, I have had to leave to others.

Among the problems of technical interest which I have worked at during many years are the manufacture of artificial camphor, of "synthetic" rubber and more particularly the permanent fireproofing of cotton goods and other inflammable materials. In considering these subjects, I concluded that the problem of the manufacture of artificial camphor was too technical to be generally interesting and my friend—Professor Duisberg—wishes to introduce the subject of "synthetic" rubber into his General Lecture so there remained the subject of permanent fireproofing which in many respects is perhaps as interesting and important and as difficult of accomplishment as the other problems I have mentioned. The problem of the prevention of fire has always been one of the most pressing and at the same time one of the most difficult and perplexing with which mankind has had to deal. In very early times wooden houses caught fire and were burnt down and it is said that the Romans attempted to render wood fireproof by dipping it in a bath made of vinegar and powdered clay.

This treatment, so strongly reminiscent of processes employed many years afterwards, would no doubt be effective in rendering the wood less liable to inflame, but it can hardly have had wide application because vinegar, in those days, was not easily obtained in quantity and was consequently an expensive substance. I have made a search in a number of old books with the object of discovering some other of the actual methods used in early times in connection with fireproofing and the first pamphlet on the subject which I have been able to find, dates from 1638 when Nikolas Sabattini published a remarkable paper in which he discussed the need of reform in the administration and construction of the theatres in Italy and pointed out the danger, which is always present, of fire breaking out on the stage, not only owing to the inflammable nature of the wood employed in the construction of the theatre and for the decorations and scenery but also on account of the inflammability of the cotton material used in the scenery and for the dresses of the players.

He recommends, as a safeguard, that the colour used in painting the theatre and scenery should be mixed with clay and gypsum but says nothing about the fireproofing of the dresses.

At a considerably later date—in 1735—Wild suggested a mixture of alum, borax and sulphuric acid for the same purpose and, in 1740, Fagot, in a paper read before the Academy in Stockholm, recommended a mixture of alum and green vitriol whereas, in the Dictionnaire de l'Industrie published in the year 1786, there is a paragraph in which it is stated that a mixture of alum, green vitriol and salt is effective in making wood and other material fireproof.

After the disastrous fire in Munich on the 14th of January, 1823, which completely destroyed the Hof and National Theatre, a large number of experiments were made with the result that the wood used in the construction of the roof and other parts of the new theatre, was painted with several coats of sodium silicate and chalk.

A coating of this kind lasts for many years and, although it does not render the wood absolutely non-inflammable, it has at least this value that the incipient fire, which as a rule begins in quite a small way, meets with resistance at the outset, progresses but slowly and is easily extinguished.

At a somewhat later date, it was discovered that wood saturated with other salts such as for example, copper sulphate or ammonium phosphate, acquires the property of resisting flame, but of all the salts, zinc chloride seems to be the most efficient for this purpose.

In the first place, zinc chloride has great affinity for, and, therefore, attaches itself readily to, woody fibre, and fibres of all kinds and material saturated with a solution of this salt and then dried, are practically non-inflammable. This salt has also this valuable property that it is a powerful antiseptic and therefore very suitable for fireproofing the wood used in the construction of hospitals and other public institutions of a similar nature.

But I do not propose to address you this afternoon at any length on the subject of the fireproofing of wood and other building materials, a subject on which I have made comparatively few experiments and of which I, therefore, have little practical knowledge.

What I wish to discuss, and I hope that the subject will prove interesting to you all, is the problem of the permanent fireproofing of wearing materials and especially of cotton and cotton goods and by permanent fireproofing I mean protection which is not removed when the materials are subjected to the ordinary domestic wash.

Many disastrous accidents are on record which have been brought about by clothing catching fire: sometimes it is the case of a child whose garments have come in contact with a spark or lighted match and sometimes disasters of much greater magnitude have resulted from the ignition of costumes made of tow or other inflammable material on the occasion of charity entertainments or fancy dress balls.

It has long been recognised that impregnation with certain salts very much reduces and indeed may entirely destroy the liability of cotton goods to inflame and, of these fireproofing agents, I may perhaps be allowed to refer to a few only of the better known and more efficient. If a garment, after washing in the ordinary way, is rinsed in a solution containing alum or is starched with a starch containing a proportion of alum, the material, after drying, shows a marked reluctance to ignite, but this treatment has many draw-backs. In the first place it makes the material very dusty, and secondly the fireproofing is only of a temporary nature since it is at once removed by contact with water and the process must therefore be repeated every time the goods are washed. I can easily demonstrate this and, in these and all my other experiments, I purposely take only very narrow strips in order that any smoke produced may not cause inconvenience in this Hall. Another solution which has been strongly recommended for the same purpose is made up with 3 parts of ammonium phosphate, 2 parts of ammonium chloride and 1 part of ammonium sulphate in about 40 parts of water. If the material after washing, is impregnated with this solution and dried, or if it is starched with starch made with the solution instead of with water, the dry material only ignites with difficulty, and, as it does not dust and is not prejudicially affected in any other way, this process has been used with advantage not only in connection with wearing material but also for the fireproofing of lace curtains and other inflammable decorations. But in this case also, the fireproofing agents employed are all soluble in water and one washing is sufficient to remove them entirely, leaving the goods at least as inflammable as before. The process must therefore be repeated every time the goods are washed and this means expense which, in the long run, becomes considerable.

But a much more serious drawback to processes of this kind is the trouble they entail since, in order to fireproof the garment the washerwoman must have alongside the ordinary wash tub, a second tub containing the fireproofing solution and this complication, added to the expense of the salts, has been shown to be so serious that processes of this kind are quite impracticable especially in the homes of the poor. Again unless the materials or garments after washing, have been dried before immersion in the fireproofing solution, this solution cannot be kept uniform since, each garment being wet when put in leaves the solution weaker than before and therefore of less protective value. To dry each garment between the washing and the fireproofing entails so much trouble and labour and expense that it would obviously prevent any general adoption of the practice. Although the substances I have mentioned and the salts of ammonium in particular, possess in a high degree the property of rendering material fireproof, there is one substance which confers the property of resisting fire to cotton goods in such a remarkable degree that is has long attracted attention and must be specially mentioned, and that is sodium tungstate.

A piece of muslin soaked in a weak solution of sodium tungstate and then dried is practically non-inflammable but unfortunately this salt is again so excessively soluble in water that a mere rinsing in clean water is sufficient to remove it completely and the fireproofing is lost. And this applies not only to sodium tungstate but also to all the other salts which have, from time to time, been recommended for fireproofing purposes; the result is not permanent because the proofing is at once removed when the goods are washed in the ordinary way.

The problem on which I was engaged for several years and which has now been successfully solved, in a very simple manner, was that of attempting to discover some process which not only made the goods non-inflammable but also *permanently* non-inflammable, and the researches on this subject were originally started in connection with flannelette, a material very largely and widely used for clothing especially by the poorer classes, and one of the most, if not the most, inflammable of all cotton goods.

Flannelette may be briefly described as a kind of calico the surface of one or both sides of which has been "carded" or "raised" into a nap, the result being that the surface of the calico becomes covered with a fluff of minute fibres somewhat resembling a thin layer of cotton wool. This effect is produced by subjecting the surface of the calico to the action of a series of revolving rollers covered with a vast number of small pieces of sharp steel wire, which tear up the surface, and the material is passed over these rollers over and over again until the required amount of nap has been raised. The result of this superficial covering of nap is—as everybody who has handled flannelette will know—a warm, pleasant and cosy feel and this is no doubt due to a covering of air being imprisoned by the minute fibres thus producing a layer which acts as a non-conductor much in the same way as in the case of flannel.

In the first two samples in the little book which you each received as you entered the Hall are calico and flannelette and you will notice at once the great difference in the feel between the comparatively hard flat surface of the calico and the raised surface of the flannelette.

Flannelette is indeed little, if at all, inferior to flannel as a non-conducting material and as it is very cheap and does not shrink in the wash, it has become very popular and is manufactured in enormous quantities and almost universally used for the clothing of children especially in the homes of the poorer classes.

But it was not long before its increasing use showed unmistakably that it has one terrible drawback,—the nap, which is its peculiar feature, makes it highly inflammable and much more so than the calico from which it was manufactured.

Flannelette is in fact, as I have already said, very much like calico on the surface of which a thin layer of cotton wool has been spread and this layer is, of course, highly inflammable.

I can easily demonstrate the difference in the inflammability of calico and flannelette by applying a light to strips of each when it will be seen that while calico burns in the ordinary way, in the case of flannelette, the flame flashes over the whole surface of the fluffy cotton layer and travels with extraordinary rapidity.

It is, of course, this property which makes flannelette one of the most dangerous of materials for clothing purposes. The alarming frequency of deaths by burning due to the wearing of flannelette became common knowledge, the coroners all over

Great Britain repeatedly called attention to the matter and by degrees the agitation against its use for clothing became so persistent that the Coroners' Committee of the Home Office was directed to enquire into the matter.

The Committee recognised that whilst, to quote the words of their Report "We think the common opinion attributing to it (flannelette) a large share of the blame (of burning accidents) is not far wrong" that it was impossible to prohibit its use without causing great hardship especially to the poor. Several years before this enquiry was held, one of the largest firms of flannelette manufacturers in Manchester, Messrs. Whipp Bros. and Tod, becoming alarmed at the frequent occurrence of fatal burning accidents and fearing lest these might lead to the prohibition of the sale of the material, came to me and asked whether I would undertake a series of experiments with the object of endeavouring to find a remedy for this state of things and, after looking carefully into the matter, I consented to do what I could. That the problem was a difficult one from many points of view will be readily understood if I briefly state the conditions which had to be kept constantly in mind while the experiments were being carried on. A process to be successful must in the first place not damage the feel or durability of the cloth or cause it to go damp as so many chemicals do, and it must not make it dusty. It must not affect the colours or the design woven into the cloth or dyed or printed upon it; nothing (such as arsenic antimony, or lead), of a poisonous nature or in any way deleterious to the skin, may be used and the fireproofing must be permanent, that is to say it must not be removed even in the case of a garment which may possibly be washed 50 times or more. Furthermore, in order that it may have a wide application, the process must be cheap. What was really to be aimed at was to treat the flannelette in such a way that it acquired practically the properties of wool which, for all ordinary purposes may be taken as the standard of a safe material. Apart from the other conditions which I have laid down, when one considers the vigor with which the ordinary washerwoman scrubs garments with soap, not infrequently with the assistance of the scrubbing brush, and takes into account the wonderful mechanical appliances now so largely used for washing clothes with the least expenditure of time, it will not be thought surprising that the discovery of a process of fireproofing sufficiently permanent to resist all these conditions seemed to me at first to be almost an impossibility.

In describing the course of the research, I may perhaps be allowed to give a brief sketch of the development of the subject and to outline the reasoning which led to the institution of the various experiments. Some idea of the difficulty of the subject will be gathered when I say that Mr. Samuel Bradbury, who so ably assisted me in the work and has kept a record of each experiment, tells me that upwards of 10,000 separate burning tests were made before the solution of the problem was reached. Besides these, a great number of further experiments have since been made to see whether an even cheaper process than that which has now been in commercial use for nearly 10 years could be discovered.

I suppose that everyone would agree that, at the outset of the experiments, the condition which seemed most difficult of realization was that of finding a substance which not only fireproofs but which during the process becomes so permanently fixed that it will prove to be absolutely resistant to washing with soap and water or mechanical rubbing. Obviously the substance which is to fulfil these conditions must, in the first place, be insoluble in water and secondly in order that it is not liable to be removed by mechanical rubbing and does not render the cloth dusty, it must be fixed in the fibre and not be merely on the surface. I have already explained that when calico is dipped in a dilute solution of sodium tungstate, and then dried the material possesses in a remarkable degree the property of resisting flame and then again alum has often been recommended for the same purpose. Now when solutions of sodium tungstate and alum are mixed, an insoluble aluminum tungstate is produced and it is clear that, if this insoluble salt could be fixed in the fibre, the material would certainly be fireproofed. It furthermore seemed reasonable to suppose that, as the salt is insoluble in water, it would remain in the fibre even after several washings and therefore that permanent fireproofing might be achieved in this manner.

A piece of flannelette was therefore soaked in sodium tungstate and, after passing through rollers, to remove the excess of the solution, left for a considerable time in a solution of alum. It was then squeezed, dried and was passed through the same process again with the result that the material became almost as fire resistant as asbestos. When, however, the piece was thoroughly washed with soap and water, it was most disappointing to find that the greater part of the fireproofing was removed during the first washing and after several washings, the material was little better than the original flannelette.

While this unexpected result was being investigated, it was noticed that aluminum tungstate is soluble in acetic acid and is reprecipitated when the acetic acid is removed by evaporation or by the action of steam and as the precipitate formed seemed granular in appearance, it was thought that this process, if applied to the flannelette, might yield a better result than the process of double decomposition had done. Accordingly, a solution was made up of sodium tungstate, aluminum sulphate and enough acetic acid to dissolve the precipitate, the flannelette was thoroughly soaked in this solution, dried and then placed in an ordinary steamer and subjected to the action of steam until the odour of acetic acid could no longer be detected.

The material was, of course, non-inflammable and when it was washed, it was found that this property was distinctly more resistant to soap and water than was the case in the first experiment but after several vigorous washings almost every trace of the fireproofing had disappeared. These negative results seemed therefore to indicate that aluminum tungstate was not suitable for the purpose of permanent fireproofing. On the other hand, the failure of this salt was possibly due to some peculiarities in its specific properties and was not considered valid evidence that other insoluble tungstates might not combine more completely with the fibre and thus resist removal by washing.

A careful examination of the tungstates was therefore made and such insoluble salts only selected for experiment which, like aluminum tungstate, are colourless since it is obvious that a fireproofing agent to be of any use must be capable of application to white cloth without staining it. Several hundred pieces of flannelette were treated under the most varied conditions with all sorts of combinations which it was known would precipitate insoluble tungstates in the fibre but in no case was a satisfactory result achieved.

However, a fact was noticed which afterwards proved to be of value and it was this that, of all the salts, the tungstates of zinc and tin seemed to offer the most resistance to washing with soap and water. Thus, when the material had been thoroughly saturated with a solution made up of sodium tungstate, zinc sulphate and enough acetic acid to prevent the precipitation of the zinc tungstate, and the goods after drying were thoroughly steamed, the fireproofing was certainly fixed to some extent since it required several washings before the material burnt at all freely. But no amount of variation of the conditions produced a really good result and this combination had therefore to be abandoned. Since the tungstate proved to be insuitable to the exacting conditions of the problem, a general examination of almost every variety of salt, including ferrocyanides, aluminates, arseniates, antimoniates, zincates and plumbates was made. Many of these could not be employed in connection with wearing apparel in any case because of their poisonous nature but it was thought that this general examination, which lasted several months, might yield some indication of the type of salt likely to prove resistant to soap and water, if, indeed, such type of salt existed at all. And as a matter of fact these experiments did prove to be most valuable because when the results were all tabulated, the generalisation gradually became apparent that certain soluble salts such as aluminates, antimoniates, zincates, and plumbates, in which the oxide of the metal functions as an acid, yielded precipitates especially with zinc and tin salts which exhibited much greater resistance to washing than the commoner insoluble salts such as harium sulphate or magnesium phosphate. This generalisation ultimately led to a very careful examination of the salts of tin because, as is well known, the oxides of tin dissolve in alkalis to form stannites and stannates and tin therefore belongs to the class of salts just mentioned and it very soon became evident that these salts do actually possess the power of combining with the fibre to a greater extent than any of the salts which had previously been experimented with.

In one experiment it was noted that a piece of flannelette, which had first been saturated with a solution of sodium stannate and dried, and afterwards similarly treated with a solution of zinc chloride, was quite non-inflammable. After the sample had been subjected to a vigorous washing with soap and water a considerable amount of the fireproofing still remained because, when a light was applied to the cloth, it only ignited with difficulty, burned very slowly, and either went out of itself or was easily extinguished on shaking the material.

This development was so promising that the experiment was repeated in a great variety of ways but, although several results were obtained which were much better than anything which had been seen before, it was disappointing to find that in all the cases the greater part of the fireproofing was lost after repeated washings.

In a later series of experiments the first solution was again sodium stannate and the second consisted of sodium tungstate, zinc acetate and sufficient acetic acid to prevent precipitation of the zinc tungstate formed. The result in this case was so good, the material being practically as safe as wool, even after repeated washings, that the first commercial permanently fireproofed flannelette which was placed on the market was made on these lines.

It was soon found, however, that the material thus treated had two serious drawbacks; it had a tendency to go damp, and an unpleasant smell of acetic acid remained even though the material had been steamed and washed, after the fireproofing process, before being sent out. And apart from these two faults, the fireproofing was still not sufficiently permanent and the cost of the process was too great for it to be considered a satisfactory one.

A further series of careful comparative tests seemed to indicate that the undoubted advance which had been made was mainly due to the use of the stannate and it was therefore decided to carry out a series of experiments using salts of tin exclusively.

The fabric after being treated with sodium stannate as before, was, in the earlier of these experiments, passed through a fixing bath containing stannous chloride. A very permanent fireproofing was again obtained but the stannous chloride being a reducing agent, tended to destroy or affect the colours of the material and the process would, therefore, be generally applicable only to white cloth.

In order to get over this difficulty stannic chloride was employed, instead of the stannous salt as the fixing agent, and to avoid any tendering of the material care was taken that the stannic chloride solution should be of such a strength that a little stannate was left unchanged in the material.

An excellent fireproofing was again obtained for not only did the material show very little tendency to inflame, after it had been washed several times with soap and water, but it had also in such other respects as appearance and feel almost ideal properties the only objectionable feature being a slight tendency to dust on rubbing and shaking. Now in this particular experiment, in which sodium stannate and stannic chloride had been employed together, the substance which must have been produced in the fibre, and to which the fireproofing must therefore have been due, is stannic oxide and it seemed clear that this oxide or its hydrate must have some remarkable power of combining with, or attaching itself to, the fibre which enables it to resist removal by washing and rubbing.

But this process still left something to be desired on the score of economy. A certain amount of the tin was undoubtedly wasted, for, in addition to that lost through a portion of the stannate being left unfixed, it was noticed that a considerable amount of the tin oxide which was formed by the action of the alkali of the stannate on the stannic chloride, was not permanently fixed in the fibres of the material, and was therefore removed during the subsequent washing. Tin is so expensive that, in a process to be commercially successful, this loss must obviously be avoided.

There are many ways in which stannic oxide may be precipitated from sodium stannate and one of these, commonly used in ordinary analytical Chemistry, consists in adding certain soluble salts such as sodium sulphate or ammonium nitrate to the solution of the stannate, when the whole of the tin is precipitated as oxide or hydrate. In order to find out whether some process of this kind would precipitate this oxide in such a condition that it would remain permanently fixed in the fibre, a number of pieces of flannelette were soaked in sodium stannate and, after thoroughly drying, separately passed through various solutions containing sodium or ammonium salts at the ordinary temperature and at temperatures up to the boiling point. Although, as was to be expected, the results were not uniformly good, a certain degree of permanent fireproofing was always achieved and consequently the matter was systematically followed up with the result that a process was gradually evolved which yielded material possessing quite remarkable properties. The process is briefly this:—

The flannelette (or other material) is run through a solution of sodium stannate of approximately 45° Tw. in such a manner that it becomes thoroughly impregnated. It is then squeezed to remove the excess of the solution, passed over heated copper drums in order to thoroughly dry it, after which it is run through a solution of ammonium sulphate of about 15° Tw. and again squeezed and dried.

Apart from the precipitated stannic oxide, the material now contains sodium sulphate and this is removed by passage through water; the material is then dried and subjected to the ordinary processes of finishing. A long series of trials, carried out under the most stringent conditions, have conclusively proved that material, subjected to this process is permanently fireproofed. No amount of washing with hot soap and water will remove the fireproofing agent, or in other words, the property of resisting flame lasts so long as the material itself lasts. I will demonstrate this by exhibiting four different specimens; (i) material as it leaves the process and before washing, (ii) material which has been washed ten times by hand, (iii) material washed 20 times in a machine in a laundry and (iv) a portion of a garment which has been in actual use for 2 years, washed every week and is, as you see, in rags. This extraordinary property of resisting soap and water seems to me to indicate that the oxide of tin is not present merely as an insoluble precipitate in the cloth but must have entered into some actual combination with the fibre, yielding a compound which is not broken down by the action of the weak alkali of the soap. But a matter of hardly less importance from the practical point of view is that the material is not only permanently fireproofed by the process I have just described, it also retains and acquires properties which make it as perfect a material in all other respects as could be desired. In the first place the treatment has no effect on the delicate colours which are now so generally employed in connection with the manufacture of flannelette and other cotton goods and very careful experiments have demonstrated the fact that the insoluble tin compound in the fibre has not the slightest deleterious action on the most delicate skin. In addition, the presence of the tin compound in the pores gives the cloth a softer and fuller feel than that of the original flannelette and what perhaps is the most unexpected result is the fact that the material is considerably strengthened by the process.

A series of tests made by the Manchester Chamber of Commerce proved that the tensile strength of flannelette is increased nearly 20 per cent as the result of the introduction of the tin compound into the fibre.

Further and very exhaustive tests made at the Municipal School of Technology, Manchester, on a machine specially designed for testing the wearing properties of fabrics, showed an even greater gain in durability in the case of the fireproofed flannelette. These separate and independent tests conclusively showed that the increase in strength and durability was approximately equal to the cost of the fireproofing treatment so that garments made from the permanently fireproofed flannelette are as a matter of fact no dearer than those made from ordinary flannelette and are at the same time as safe as if made from flannel. Some of these properties and statements may be easily tested by each of you independently with the samples in the little book which you received on entering the Hall.

This permanently fireproofed flannelette is now manufactured on the large scale by Messrs. Whipp Bros. and Tod in Manchester under the name of "Non-Flam" and, although its introduction has been slow, it is being increasingly used and will, in all probability, ultimately entirely replace the ordinary inflammable variety. One of the difficulties experienced in connection with its general introduction is the fact, that, owing to the high price of tin, which is now quoted at about £210 or $1050 per ton, the cost of the process is not inconsiderable but, even with tin at this high price, the extra cost is not more than 1d. (2 cents) per yard or about 1½d or 2d (3–4 cents) for a child's garment. I have here on the table, rolls of "Non-Flam" of different qualities so that anyone who wishes for a larger sample than is contained in the little book can easily obtain it.

It is hardly necessary for me to say that this process can be applied to any cotton fabric and is especially valuable in connection with muslin because this material is so often used, especially on the stage, for dresses which, on account of their flimsy nature, are naturally highly inflammable. I have here two strips of the same muslin one of which has been treated by the "Non-Flam" process without in any way affecting its ordinary properties and was then washed 10 times and the difference in inflammability of the two samples is very striking. Whilst the first sample is highly dangerous, it is difficult to imagine that harm could come to anyone who happened to be dressed in the treated material even if, by accident, a lighted match came in contact with the dress. Another direction in which the process may be used with great advantage is in connection with lace curtains. Many disastrous fires have occurred by reason of the ignition of lace curtains and there can be no doubt that the greater majority of these would have been avoided if the curtains had been treated by the "Non-Flam" process. As an example of this, I have here a strip of lace curtain which has been subjected to the process and then washed a number of times and it will be seen that if such material did accidentally come in contact with a lighted match, the danger of fire is reduced to a minimum because even supposing the material did catch fire, the flame is put out at once by the least shake.

It seems to me that it is obvious that, if this process or some other process capable of giving the same protection from fire, was adopted in the case of all inflammable cotton goods and especially in the case of material used for garments, many disastrous fires and the appalling loss of life especially among young children, might be avoided and it is for this reason that I have ventured to bring the subject of the permanent fireproofing of cotton goods to your notice this afternoon.

Dr. Frank W. Clarke in seconding Professor Chandler's motion for a vote of thanks expressed his gratification to Professor Perkin for his kindling and illuminating lecture. In an address delivered yesterday much was said about the discovery of the coal tar colors by the elder Perkin. It is practically certain that every person in this audience is wearing some article of apparal which is colored wholly, or in part, with dyes derived from coal tar. If, now, you will add to your obligation to the elder Perkin by wearing apparel also rendered non-flammable, the invention of the son, you will begin to realize your debt of gratitude to the Perkin family.

In conclusion, let me say that Professor Perkin is not merely to be thanked for this address, but also congratulated on the success of his investigations.

The motion was carried unanimously amid great applause.

General Lecture of Wednesday, September 11, 1912

Program of Organ Recital

Professor Samuel A. Baldwin, *organist*

1	Cora Caudiosa dedicated to Mr. Baldwin	*M. Enrico Bossi*
2	Cora Mystica	*Luigi Boccherini*
3	Intermezzo "The Jewels of the Madonna"	*Ermanno Wolf-Ferrari*
4	Overture to "William Tell"	*Giachino Rossini*

Address of Giacomo Ciamician, Bologna

LA PHOTOCHIMICA DELL'AVENIRE

La civiltà moderna è figlia del carbon fossile: questo offre all'umanità civile l'energia solare nella forma più concentrata: accumulata nel tempo d'una lunga serie di secoli, l'uomo moderno se n'è servito e se ne serve con crescente avidità e spensierata prodigalità per la conquista del mondo. Come il mitico oro del Reno, il carbon fossile è per ora la sorgente precipua di forza e di ricchezza.

La terra ne possiede ancora enormi giacimenti: ma essi non sono inesauribili. Il problema dell'avvenire comincia ad interessare e prova ne sis che lo scorso anno ne trattarono quasi contemporaneamente Sir William Ramsay alla British Association for the advancement of Science a Portsmouth ed il Prof. Carl Engler alla Versammlung deutscher Naturforscher und Aerzte a Karlsruhe. Secondo i calcoli di quest'ultimo, l'Europa possederebbe un patrimonio di circa 700 miliardi di tonnellate di carbon fossile e l'America altrettanto; a questi giacimenti sono da aggiungersi quelli ancora in parte sconosciuti dell'Asia. Il deposito è enorme, ma col consumo crescente lo sfruttamento si fa sempre più costoso per le crescenti profondità a cui bisogna arrivare; il problema quindi, se in certi paesi i giacimenti possano diventare praticamente inutilizzabili assai prima del loro esaurimento materiale, non è trascurabile.

L'energia solare fossile è la sola che possa giovare ala vita e alla civiltà moderna? That is the question.

Un esame assai accurato di questo problema dal punto di vista inglese è stato fatto da Sir William Ramsay. Egli ha preso in considerazione le diverse sorgenti d'energia quali le maree, il calore interno della terra, il calore solare, il carbone bianco, lo sviluppo delle foreste e delle torbiere e perfino la disintegrazione atomica, ed è arrivato alla conclusione che nessuna apiparisce praticeamente utilizzabile in Inghilterra date le sue condizioni orografiche e climatiche.

Certamente l'energia endogena terrestre, che col vulcanismo ed i terremoti può produrre spaventosi disastri, sarà difficilmente ammansita dall'uomo e così pure quella derivante dalla rotazione terrestre (maree), causa l'enorme quantità d'acqua che bisognerebbe vincere. La trasmutazione atomica è stata oggetto recentemente d'un brillante discorso di Federico Soody dal punto di vista dell'imponente fenomeno esoenergetico ch'essa rappresenta: se all'uomo sarà dato realizzare un simile sogno, di giovarsi cioè dell'energia interna degli atomi, la sua potenza sorpasserà di gran lunga i limiti che ora gli sono assegnati. Questi presentemente sono dati dall'energia solare: vediamo se l'energia *attuale* possa in genere supplire a quella racchiusa nei combustibuli fossili. Ammettendo la costante solare di circa 3 piccole calorie al minuto per centimetro quadrato, ossia 30 grandi calorie per metro quadrato al minuto e 1800 all'ora, si può comparare questa quantità di calore con quella data dalla combustione completa di un chilogrammo di carbone, che è di 8000 grandi calorie. Calcolando pei tropici la giornata di sole sei ore, si avrebbe al giorno una quantità di calore corrispondente a quella data da 1,35 chilogrammi di carbone, ossia in cifre tonde di 1 chilogramma. Per un chilometro quadrato questa quantità di calore viene ad equivalere a quella prodotta dalla combustione completa di 1000 tonnellate di carbone. Sopra un territorio che abbia la superficie di soli 10 mila chilometri quadrati, la quantità di energia solare che arriva in un anno, calcolando la giornata di sei ore, corrisponde quindi al calore fornito da 3650 milioni di tonnellate di carbone dunque, in cifra tonda 3 miliardi di tonnellate. La quantità di carbone fossile prodotta annualmente

(1909) dalle miniere d'Europa e d'America si calcola a 925 milioni di tonnellate ed aggiungendo a questa cifra 175 milioni di tonnellate di lignite si arriva a 1100 milioni ossia a poco piu di un miliardo. Però anche tenendo conto dell'assorbimento nell' atmosfera e di altre circostanze, si vede che la quantità di energia solare che arriva annualmente in un piccolo territorio tropicale che abbia una superficie ad es: grande come quella del Lazio—equivale alle produzione annuale mondiale di carbone fossile! Il deserto di Sahara coi suoi 6 milioni di chilometri qaudrati, ne riceve giornal mente per 6 miliardi Iddi tonnellate!

Questa enorme quantità di energia che la terra riceve dal sole, rispetto a cui quella immagazzinata dalle piante nei periodi geologici è quasi trascurabile, va in gran parte dispersa. Essa viene utilizzata colle cadute d'acqua (carbone bianco) e dalle piante. Al suo impiego diretto termico-mecanico per mezzo di specchi s'è più volte pensato ed ora si fanno delle prove assai promettenti in Egitto ed al Perù, ma questo lato assai interessante del problema esorbita dalla mia competenza e però di esso non intendo trattare. L'energia prodotta dalle cadute d'acqua, secondo i dati contenuti nel bel discorso del Prof. Engler sopra, l'intera superficie terrestre equivarrebbe annualmente a 70 milliardi di tonnellate di carbone. Come si vede, e com'è naturale, assai poco rispetto alla totalità dell'energia solare che annualmente investe la terra. Vediamo ora quale sia all'incirca la quantità di energia solare che annualmente viene fissata dalle piante: sulla superficie cintinentale terrestre, di 128 milioni di chilometri quadrati, si producono annualmente per 32 miliardi di sostanza organica secca, la quale, bruciata, darebbe una quantità di calore corrispondente a quella di 18 miliardi di tonnellate di carbone. E' poco, ma tuttavia questo poco è già ora 17 volte superiore alla attuale produzione mondiale dicarbone fossile e lignite in un anno.

I

Ed ora entriamo nella prima parte del nostro argomento. È possibile, o per dir meglio, si può pensare che sarà possibile di fare aumentare questa produzione di materia organica vegetale in genere, di intensificarla in luoghi voluti, di intervenire inoltre nella cultura delle piante in modo di farle produrre più abbondantemente quelle sostanze che possono servire di sorgenti d'energia o che sono altrimenti utili alla civiltà? Io credo di si. Naturalmente con ciò non si pretende di sostituire al carbone fossile la materia organica prodotta dalle piante, ma si può pensare se non sia conveniente trarre da questa un utile maggiore.

Sovente è stato detto anche da persone autorevoli che la conversione del carbone in pane potrebbe diventare un giorno non solo possibile, ma anche economicamente desiderabile: secondo costoro l'ideale futuro sarebbe quello di produrre per sintesi dal carbone tutte le sostanze fondamentali per l'alimentazione umana: come l'amido, lo zucchero ed i grassi ed anche le proteine ed oltre a queste forse pure la stessa cellulosa; di abolire cioè l'agricoltura e convertire però il mondo in un gran parco di inutili fiori. Mai aberrazione maggiore è stata pensata ed espressa: il problema esiste soltanto nel senso inverso. Il mio amico Prof. Angeli mi faceva giustamente osservare a questo proposito, che mentre l'esteriorità della vita s'è modificata profondamente coi progressi dell'industria in modo che il così detto comfort moderno usufruisce di tutti i ritrovati gella tecnica, il genere e la quantità dell'alimentazione umana non hanno subito alcuna variazione; anzi è sorta una nuova scienza, quella appunto degli alimenti (bromatologia), per invigilare che nessun prodotto dell'industria entri abusivamente nella nostra alimentazione. Ai tempi di Napoleone III, s'era tentato di sostituire la gelatina alla carne, ma tosto si vide, ed ora è ben chiara la ragione, per cui questo surrogato non poteva bastare a mantenere la vita. Non potrà mai apparire conveniente di produrre con le relativamente piccole riserve di carbone, che le passate epoche geologiche ci hanno dato in retaggio, quello che la natura gratuitamente ci offre su larga scala frutto dell'energia solare. E'opera degna di plauso invece il tentare di far produrre alle piante in maggiore copia le sostanze fondamentali, ed a questo la moderna agricoltura largamente si avvia coll'intensificazione della coltura, ma ciò che può apparire vantaggioso è di giovarsi delle piante anche per fissare l'energia solare e convertirla in energia meccanica.

Quando, per citare un esempio relativo ad un altro quesito, coll'enorme sviluppo della stampa quotidiana in tutti i paesi civili s'è dovuto provvedere ad una adeguata quantità di carta a buon mercato mediante l'uso della pasta di legno, si trovarono subito alberi adatti, a rapido crescimento per fornire la cellulosa necessaria. Pel problema che ora ci riguarda, la qualità delle piante è fino ad un certo punto indifferente: possono essere arboree, di basso fusto o erbacee, a coltura asciutta o paludosa ed anche salmastre, o magari marine. L'essenziale è che crescan presto o per dir meglio che siano atte ad essere catalizzate nel loro crescimento; si tratterebbe di realizzare per cosi dire il desiderio di Faust:

Und Bäume die sich täglich neu begrünen!

Mefistofele per conto suo non riteneva impossible un simile compito:

Ein solcher Auftrag schreckt mich nicht,
Mit solchen Schätzen kann ich dienen.

Lo riterremmo noi, naturalmente in limiti assai più ristretti, dopo tanti secoli di coltura? Io non lo credo davvero. Il calcolo precedente per dedurre la produzione annuale di sostanza organica secca vegetale su tutta la superficie continentale terrestre, che, come s'e detto, ammonta a 32 miliardi di tonnellate, ha per base il vecchio dato di Liebig di 2,5 tonnellate per ettaro. Questa cifra può valere anche oggi come media generale per la produzione annuale di tutta la terra. Per altro con culture intensive, secondo A. Mayer, la produzione può essere spinta a 10 tonnellate per ettaro ed in climi tropicali può raggiungere anche le 15 tonnellate. Per chilometro quadrato la cifra ascende a 1500 tonnellate, corrispondente a 840 tonnellate di carbone; essendo poi l'energia solare ricevuta in un anno sul chilometro quadrato equivalente a circa 300 mila tonnellate di carbone, la parte assorbita dalle piante sarebbe di circa 1/300. Molto resta adunque ancora a fare, ma se si riflette che da Liebig in qua, giovandosi in fondo soltanto dei mezzi da lui proposti, la produzione ha potuto essere per lo meno quadruplicata, molto resta anche da sperare dall'avvenire, massime quando spinga la necessità o anche la semplice convenienza.

Ora non è impossibile pensare che aumentando fino ad un certo limite la concentrazione dell'anidride carbonica[1] e facendo uso di catalizzatori, si possa arrivare ad aumentare notevolmente la produzione di materia organica vegetale, impiegando naturalmente nel modo più abbondante i concimi minerali opportuni e scegliendo regioni adatte per clima e condizioni di terreno. La messe, seccata al sole, dovrebbe venire convertita integralmente nel modo il più perfetto in combustibile gassoso, avendo cura di fissare durante questa operazione l'ammoniaca (ad es: col sistema Mond) per restituirla poi al terreno quale concime azotato, assieme a tutte le sostanze minerali delle ceneri. Così si verrebbe a formare un ciclo rispetto alle materie fertilizzanti minerali, salvo le perdite inevitabili in ogni processo industriale. Il gas così prodotto dovrebbe essere bruciato completamente sul posto in una macchina termica e l'engeria meccanica ricavata fissata per l'esportazione od altrimenti ultilizzata in modo di cui quì non importa trattare. L'anidride carbonica della combustione invece di lasciarla disperdere nell'aria dovrebbe essere condott a nei campi di coltura. Così l'energia solatre fissata per mezzo di una razionale coltura potrebbe fornire energia meccanica a buon mercato e ciò forse meglio che con sistemi a base di reflettori termico-meccanici, perchè le piante accumulano l'energia ricevuta.

Ma il problema della utilizzazione delle piante in concorrenza con quella del carbone fossile ha un altro lato assai più interessante. Anzitutto conviene ricordare le industrie che hanno per fondamento l'agricoltura: quella del cotone e fibre tessili, dell'amido, e della fermentazione alcoolica, delle materie grasse con tutte le sue derivazioni, la distillazione del legno, l'estrazione dello zucchero, delle materie tanniche e tante altre minori. Tutte queste industrie sono suscettibili di miglioramento non solo nel senso ordinario di ulteriori progressi nelle manipolazioni delle materie gregge, ma bensì in quello di una maggiore produzione di queste ultime. Si pensi ai progressi fatti per es: nella produzione dello zucchero per mezzo delle barbabietole:

Ora le piante oltre ad essere insuperate maestre o meglio ancora officine mirabili nella sintesi fotochimica delle materie fondamentali partendo dall'anidride carbonica col concorso dell'energia solare, producono con eguale semplicità le così dette sostanze secondarie. Queste ultime, che si ritrovano nelle piante quasi sempre in piccola quantità, sono preziose per altre ragioni. Gli alcaloidi, i glucosidi, le essenze e le canfore, la gomma elastica, le materie coloranti ed altre ancora interessarono ed interessano l'industria organica assai più delle sostanze fondamentali, trattandosi di prodotti d'alto valore commerciale. In questo campo s'è impegnata una lotta fra l'idustria chimica e la natura, che fa veramente onore al genio ed alla perspicacia umana. Finora il catrame del carbone fossile ha riportato quasi sempre la vittoria. Quali siano queste vittorie non ho bisogno di ricordarlo a Voi, ma per altro non si può a meno di pensare che esse potrebbero diventare vittorie di Pirro. Una grande autorità nel campo delle industrie organiche considerava tempo fa il caso in cui, per varie ragioni, il prezzo del catrame del carbone fossile, e però anche quello delle materie prime in esso contenute, potesse subire un sensible aumento e ne traeva le evidenti conclusioni per l'avvenire delle industrie che a quelle fanno capo. Tutti ricordano con ammirazione le grandi difficoltà che dovettero essere superare a proposito della scelta della materia prima per la produzione industriale dell'indaco: si dovette ricorrere alla naftalina perchè il toluolo non poteva aversi nella quantità voluta. Man non è soltanto l'inasprimento dei prezzi delle materie prime che può arrestare l'industria, essa può subire per lo meno una stasi per l'esaurimento dell'interesse scientifico per un dato campo di studi. Come è stato largamente riconosciuto, l'industria moderna è strettamente collegata colla scienza pura: il progresso dell'una determina necessariamente quello dell'altra. Ora evidentemente la chimica del benzolo e dei suoi derivati, non costituisce più il tema favorito come nella seconda metà del secolo scorso, ma assai più le materi e di problemi relativi alla biologia. E'lo studio della chimica organica degli organismi che sempre più s'impone ed è su tali argomenti che si concentra l'atuale interesse. Non può mancare che questo indirizzo si ripercuota nella tecnica e possa segnare nuove vie all'industria.

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[1] L'optimum sarebbe secondo Kreusler fra l'uno ed il 10% di anidride carbonica.

Del resto negli ultimi tempi alcune industrie organiche si sono sviluppate rigogliosamente all'infuori dell'anello benzolico del catrame. Le essenze ed i profumi, alcuni alcaloidi, come ad es: quelli della coca, sono oggetto di fiorenti industrie, in cui si cerca di giovarsi di quelle materie che le piante producono in quantità relativamente abbondante per convertirle in prodotti di maggior valore. Come tutti, sanno, ad es: dal citrale del lemongras oil si prepara l'essenza di violetta. In questo indirizzo si deve perseverare perchè esso offre arra di sicuro progresso. E'da sperarsi che la gomma elastica possa presto essere ottenuta utilmente persimile via.

Ma la questione ha un altro lato che credo possa meritare la Vostra attenzione: riguarda certe esperienze eseguite recentemente da me assieme al Prof. Ravenna a Bologna. Non perchè io voglia attribuire a questi studi una qualche importanza pratica, ma perchè essi provano come is possa intervenire direttamente nella vita delle piante e modificare in un certo senso i processi chimici che in esse si compiono. In una serie di esperienze dirette a determinare la funzione fisiologica dei glucosidi, noi siamo riusciti a farli produrre a piante che naturalmente non ne contengono. Così ad es: abbiamo potuto, con opportune inoculazioni, costringere il Mais a fare la sintesi della salicina. E più recentemente, occupandoci della funzione degli alcaloidi nelle piante, ci è stato possible modificare la produzione della nicotina nel tabacco in guisa d'ottenere un notevole aumento oppure una diminuzione dell'alcaloide in esso contenuto. Questo è l'inizio, ma non vi pare possibile che con opportuni sistemi di coltura ed interventi si possa arrivare a fare produrre alle piante in copia maggiore di quanto non lo facciano normalmente, quelle sostanze che sono utili alla vita moderna e che noi ora con così gravi artifici cerchiamo di fabbricare coi modesti proventi del catrame del carbon fossile? Nè può aver importanza il timore di sottrarre i campi alla produzione delle materie alimentari per favorire quella industriale. Un calcolo anche approssimativo dimostra che sulla terra v'è largamente posto per tutto e per tutti, massime quando le colture sieno debitamente perfezionate ed intensificate ed adattate razionalmente alle condizioni del clima e del suolo. Ciò costituisce appunto il problema dell'avvenire.

II

L'industria organica può aspettarsi ancor molti aiuti dalal fitochimica intesa nel senso ora indicato e la concorrenza fra questa e la chimica del catrame potrà essere incentivo di nuovi progressi. Per altro all'ingegno umano sorriderà sempre il proposito di progredire con le proprie forze e non v'ha dubbio che il grande sviluppo dell'industria del catrame è stato in parte promosso da questo superbo spirito di indipendenza. Sorge però il problema se non vi sia altro modo di produzione che possa gareggiare coi processi fotochimici dei vegetali. La risposta stà nell'avvenire della fotochimica industriale su cui intendo esporre brevemente alcune idee. I processi fotochimici non ebbero finora nessun rilevante impiego pratico all'infuori di quelli fotografici. La fotografia destò fino daissuoi primordi il più grande interesse: la tecnica se ne impossessò e, come sempre avviene, ne promosse un rapido e brillante sviluppo. Malgrado le loro larghe applicazioni, i metodi fotografici non rappresentano per altro che un campo ristretto della fotochimica. Questa è stata in genere finora poco coltivata, fors'anche perchè i chimici ne furono distolti da altri problemi che apparivano più urgenti. Così ad es: mentre la termochimica e l'elettrochimica vantano già fiorenti periodi di sviluppo, la fotochimica è ai suoi primordi. Ora peraltro v'e un certo risveglio dovuto ad una serie di studi relativi ai problemi generali e ai singoli processi, massime nel campo organico a cui il mio amico ditt. Paolo Silber ed io abbiamo preso viva parte; di questo progresso fanno fede anche due recenti trattati come quello del Plotnikow e l'altro del Benrath. Molto resta peraltro ancora a fare tanto nella fotochimica teoretica e generale che in quella speciale.

Le reazioni fotochimiche seguone le leggi fondamentali dell' affinità, ma hanno particolari caratteri. Si distinguono segnatamente per il loro piccolo coefficiente di temperatura e sono però comparabili—ciò che tecnicamente non è senza importanza—alle reazioni che avvengono a temperature elevatissime. Secondo una geniale idea del Plotnikow le radiazioni luminose provocherebbero una ionizzazione diversa da quella elettrolitica: la separazione di un ione richiede poi una quantità di luce che è determinata dalla teorica di Plank e Einstein: la questione si attacca quindi alle più recenti ed elevate speculazioni della fisica matematica.

Per le nostre considerazioni, il problema fondamentale dal punto di vista tecnico è quello di fissare con opportune reazioni fotochimiche l'energia solare. Per far questo basterebbe potere imitare il processo d'assimilazione delle piante. Esse trasformano, come è ben noto, l'anidride carbonica atmosferica in materie zuccherine (amido) con sviluppo di ossigeno. Invertono in altri termini l'ordinario processo di combustione. Che il primo prodotto dell'assimilazione sia l'aldeide formica è sempre apparso assai probabile, ora Curtius ne avrebbe finalmente dimostrata la presenza nelle foglie di faggio. La riproduzione artificiale di un simile processo mediante i raggi ultravioletti è già stata realizzata da D. Berthelot: con opportuni perfesionamenti non potrebbe esso venire utilizzato già ora negli altipiani tropicali? Peraltro la vera soluzione stà nel trovare il modo di giovarsi delle radiazioni che attraverso all'intera atmosfera arrivano più abbondatemente sulla superficie terrestre. Che questo problema sia possibile, lo provano appunte le piante. Con opportuni sensibilizzatori e catalizzatori si dovrebbe poter trasformare il miscuglio d'acqua ed anidride carbonica in ossigeno e metano o eseguire altri analoghi processi endoenergetici. Le regioni desertiche tropicali dove le condizioni del suolo e del clima rendono impossibille ogni ordinaria coltura, sarebbero aperte allo sfruttamento, per l'energia solare che esse ricevono tutto l'anno in misura così larga da equivalere a miliardi di tonnellate di carbone.

Oltre a questo processo, che rimetterebbe in valore i prodotti perduti della combustione, se ne conoscono vari altri che sono determinati dalle radiazioni ultraviolette e che potrebbero con sensibilizzatori opportuni diventare accessibili alle radiazioni ordinarie. Le sintesi dell'ozono, dell'anidride solforica, dell'ammonia ca e degli ossidi d'azoto e tante altre potrebbero diventare oggetto di processi fotochimici industriali.

Si potrebbero poi immaginare varie pile fotoelettriche ed anche pile a base di processi fotochimici.[1]

Passando al campo della chimica organica le reazioni che vengono determinate dalla luce sono così molteplici che non deve essere impossibile trovarne delle praticamente utilizzabili. La luce favorisce in modo speciale i processi di reciproche ossidazioni e riduzioni che implicano o sono associati a fenomini di condensazione. E siccome la condensazione preferita è assai spesso quella del tipo aldolico v'è molto da sperare per l'avvenire, perchè la condensazione aldolica è la reazione fondamentale della sintesi organica. Alcune esperienze eseguite recentemente dal mio amico Silber e da me possono servire a questo proposito di illustra zione ed esempio. Il caso più semplice è dato dall'azione della luce sul miscuglio di acetone ed alcool metilico in cui

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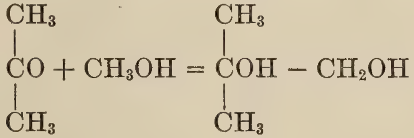
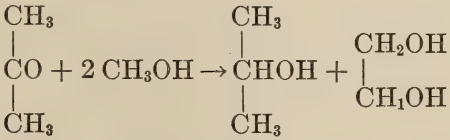
[1] Come ad esempio nelle esperienze di Chr. Winther.



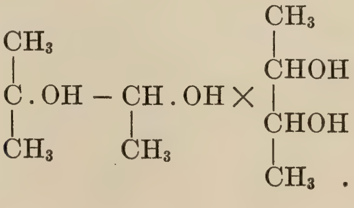
$$\begin{array}{lcll} CH_3 & & CH_3 & \\ | & & | & \\ CO & + CH_3OH = & COH & - CH_2OH \\ | & & | & \\ CH_3 & & CH_3 & \end{array}$$

si produce il glicol isobutilenico. Ma questa condensazione, che per sè stessa può essere considerata come un processo di contemporanea ossidazione e riduzione, è accompagnato dalla riduzione del chetone ad alcool isopropilico ed ossidazione a sua volta dell' alcool metilico ad aldeide formica, la quale peraltro non permane nei prodotti dell'insolazione, perchè si condensa con sè stessa e si trasforma in glicol etilenico:



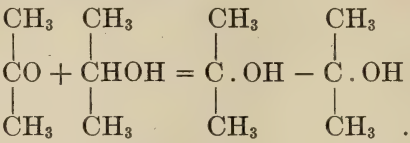
$$\begin{array}{lclcl} CH_3 & & CH_3 & & \\ | & & | & & CH_2OH \\ CO & + 2\,CH_3OH \rightarrow & CHOH & + & | \\ | & & | & & CH_1OH \\ CH_3 & & CH_3 & & \end{array}$$

Applicando la stessa reazione fotochimica al miscuglio di acetone ed alcool etilico si hanno gli analoghi prodotti: il glicol trimetiletilenico ed assieme a questo l'alcool isopropilico ed il glicol dimetiletilenico:



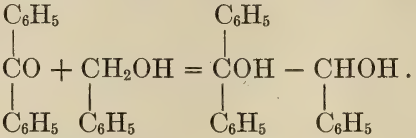
$$\begin{array}{llll} & & & CH_3 \\ CH_3 & & & | \\ | & & & CHOH \\ C.OH & - CH.OH & \times & | \\ | & \;\;| & & CHOH \\ CH_3 & \;\;CH_3 & & | \\ & & & CH_3\;. \end{array}$$

Coll'acetone e l'alcool isopropilico, come era da prevedersi, si forma semplicemente il pinacone:



$$\begin{array}{ccccccc} \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} \\ | & & | & & | & & | \\ \mathrm{CO} & + & \mathrm{CHOH} & = & \mathrm{C.OH} & - & \mathrm{C.OH} \\ | & & | & & | & & | \\ \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} \end{array} .$$

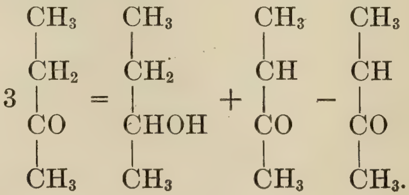
Nella serie aromatica, il benzofenone e l'alcool benzilico, assieme ad altri prodotti, danno il glicol trifeniletilenico:



$$\begin{array}{ccccccc} \mathrm{C_6H_5} & & & & \mathrm{C_6H_5} & & \\ | & & & & | & & \\ \mathrm{CO} & + & \mathrm{CH_2OH} & = & \mathrm{COH} & - & \mathrm{CHOH} . \\ | & & | & & | & & | \\ \mathrm{C_6H_5} & & \mathrm{C_6H_5} & & \mathrm{C_6H_5} & & \mathrm{C_6H_5} \end{array}$$

Questo fu il primo caso in cui tale condensazione venne osservata, a cui fecero seguito altre analoghe studiate dal Paternò impiegando in luogo dell'alcool benzilico varie altre sostanze aromatiche. Che anche le aldeidi dieno origine a processi di condensazione, lo dimostrarono anzitutto le osservazioni di Klinger a cui tennero dietro quelle del Benrath.

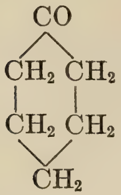
Per avere una idea sulla varietà delle reazioni fotochimiche basterebbe anche limitarsi allo studio sistematico dei chetoni e degli alcooli. Nella chimica organica ordinaria, le reazioni si ripetono sovente in modo schematico: quelle fotochimiche presentano invece delle sorprese e sono pero talvolta assai divertenti. Fino dalle nostre prime esperienze sapevamo ad es: che il suddeto benzofenone non si addiziona all'alcool etilico, ma invece si trasforma integralmente nel pinacone a spese dell'alcool che si ossida ad aldeide. Proseguendo nello studio dei chetoni alifatici omologhi dell'acetone, abbiamo trovato quest'anno un fatto assai rimarchevole. Il metiletilchetone si condensa con sè stesso per formare un paradichetone, riducendosi in pari tempo ad alcool butilico secondario:



$$\begin{array}{cccccccc} & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} \\ & | & & | & & | & & | \\ & \mathrm{CH_2} & & \mathrm{CH_2} & & \mathrm{CH} & & \mathrm{CH} \\ 3 & | & = & | & + & | & - & | \\ & \mathrm{CO} & & \mathrm{CHOH} & & \mathrm{CO} & & \mathrm{CO} \\ & | & & | & & | & & | \\ & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3}. \end{array}$$

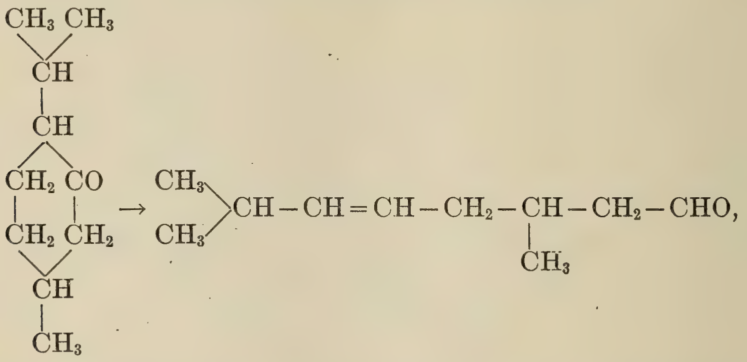
Naturalmente la sintesi di dichetoni alla luce non poteva costituire una reazione eccezionale: già altra volta avevamo notato la formazione del diacetile; l'acetonilacetone si trova, come ora sappiamo, fra i prodotti provenienti dall'acetone in soluzione d'alcool etilico ed è possibile che anche i metadichetoni, ad es: l'acetilacetone, possano ottenersi per via fotochimica. Questi processi hanno una evidente importanza per i caratteri peculiari dei dichetoni che sono in grado di subire le più svariate metamorfosi: da essi possono ottenersi derivati del benzolo; del pirrazolo ed isossazolo; della chinolina, del furano, del tiofene e del pirrolo. Anzi a proposito di que st'ultima metamorfosi, vorrei ricordare che al nostro suaccennato paradichetone corrisponde il tetrametilpirrolo. Volendo-essere arditi, come contro le mie abitudini lo sono in questa occasione, e Voi ne avete la prova, spinto forse incossientemente dal genio americano che non conosce ostacoli, si potrebbe pensare alle relazioni che esistono fra i pirroli polisostituiti con radicali alcoolici e la clorofilla e vedere in queste reazioni la possibilità della sintesi di questa fondamentale sostanza per via fotochimica artificiale. La sua formazione nelle piante è dovuta ad un processo fotochimico come la sua funzione: non si sà peraltro se ed in qual misure la luce intervenga in tutti i processi sintetici vegetali, da cui prendono origine le tante sostanze che in esse si rinvengono. Le indagini dovrebbero procedere di pari passo, chè la fitochimica e la fotochimica troveranno nelle loro reciproche relazioni vicendevole aiuto. Tale cooperazione potrebbe avere industrialmente un grande avvenire. I prodotti grezzi formati dalle piante potrebbero essere perfezionati con processi fotochimici artificiali.

In questi ultimi tempi noi ci siamo occupati assai intensamente delle modificazioni che certe sostanze appartenenti al gruppo dei terpeni e della canfora subiscono alla luce segnatamente per processi idrolitici. Finora veramente le nostre esperienze ci hanno insegnato come la luce possa guastare l'essenze in luogo di migliorarle. Così ad esempio, i ciclochetoni si idrolizzano per dare i corrispondenti acidi grassi: il cicloesanone dà l'acido capronico, il mentone l'acido decilico.

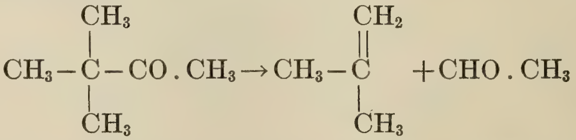


$+ H_2O = CH_3 . CH_2 . CH_2 . CH_2 . CH_2 . COOH.$

In fotochimica per altro un'azione non esclude l'altra; le reazioni possono essere invertite come lo dimostrano alcune recenti esperienze con la luce ultravioletta, la quale in certi casi inverte le reazioni determinate delle radiazioni meno rifranibili. Si tratterebbe di adoperare opportuni sensibilizzatori o catalizzatori. Del resto la fotolisi dei chetoni, che spesso accompagna l'idrolisi, per cui, ad es:, dal metone si ottiene l'isocitronellale,



l'apertura della canfora e la sua trasformazione in un ciclochetone non saturo ed altri simili fanno già prevedere quello che l'avvenire potrebbe dare. L'analoga scissione della pinacolina in butilene ed aldeide acetica



$$CH_3-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-CO . CH_3 \rightarrow CH_3-\underset{CH_3}{\overset{CH_2}{\overset{\|}{\underset{|}{C}}}} + CHO . CH_3$$

è rimarchevole perchè dimostra quali violente scomposizioni possa produrre la luce. Essa puo esserci nemica, ma conviene appunto conoscere bene le armi degli avversari quando si voglia sottometterli per valersi delle loro forze.

In non credo per altro che la tecnica debba aspettare ancora a lungo prima di trarre vantaggio dagli effetti chimici della luce. I processi di polimerizzazione, le trasformazioni isomeriche, le idrolisi, i processi di riduzione ed ossidazione con interventi organici ed inorganici, le autossidazioni che la luce provoca tanto facilmente, devono trovare profittevoli applicazioni industriali, quando le indagini siano opportunamente dirette a tale scopo. Il contegno dei composit nitrici e nitrosilici alla luce quale già ora l'esperienza ce lo ha fatto conoscere, potrà prestarsi a metamorfosi utilizzabili. La nostra nota trasformazione dell'aldeide ortonitrobenzoica in acido nitrosobenzoico, che ebbe tanto seguito per opera di varii sperimentatori, fino alla sua recentissima applicazione dovuta al Pfeiffer, il quale ottenne dal clorodinitrostilbene un nitrofenilisatogeno, fa ricordare la non meno nota trasformazione del benziliden o nitroacetofenone in indaco di Engler e Dorant e fa prevedere un nuovo indirizzo fotochimico per le materie coloranti artificiali. Il compito degli studi in proposito non deve essere limitato a preservare le materie coloranti dai processi di sbiadimento e sbianchimento ed in genere dalle alterazioni prodotte dalla luce. La fotochimica delle materie coloranti deve essere sorgente di nuovi metodi di preparazione e di tintoria. Già esistono pregievoli esperienze in proposito relative ai composti diazoici e merita menzione la recente osservazione di Baudisch per cui l'α-nitrosonaftilidrossilammina si trasforma per insolazione sulla fibra in azossinaftalina. L'autossidazione dei leuco-composti alla luce è una vecchia pratica di cui si giovavano già gli antichi per la porpora: ora il meccanismo è chiarito grazie alle note ricerche del Friedländer, ma è evidente che in questo campo resta ancor molto a fare.

Le sostanze fototropiche che assumono alla luce colorazioni spesso molto intense, che poi allo scuro ritornano al colore primitivo, si presterebbero ad applicazioni di grande effetto. Assai più delle matterie fluorescenti, che danno sui tessuti colori cangianti, potrebbero attirare l'attenzione della moda tessuti con opportune sostanze fototrope. Il vestito d'una signora che fosse similmente preparato, cambierebbe di colore a seconda l'intensità della luce. Passando dall'ombra al sole si vedrebbero accendersi le tinte per cui la veste s'intonerebbe coll'ambiente in modo automatico: "le dernier cri de la mode à venir."

L'energia solare non si spande ugualmente sulla terra: vi sono regioni privilegiate ed altre che la latitudine e le condizioni de clima rendono meno favorite. L'avvenire sarebbe per le prime quando l'industria sapesse utilizzare, nel modo ch'io ho cercato di abbozzare, l'energia che il sole vi profonde. I paesi tropicali verrebbero così conquistati alla civiltà che tornerebbe alle sue origini: le nazioni più progredite quasi presentendo inconsciamente questa necessità gareggiano nella conquista delle regioni del sole.

Là dove la vegetazione è ubertosa e la fotochimica puo essere abbandonata alle piante, si potrà con colture razionali, come ho già accennato, giovarsi delle radiazioni solari per promuovere la produzione industriale. Nelle regioni desertiche invece dove le condizioni del clima e del suolo proibiscono ogni cultura, sarà la fotochimica artificiale che la metterà in valore. Sull'arido suolo sorgeranno colonie industriali senza fuliggine e senza camnii: selve di tubi di vetro e serre d'ogni dimensione—camere di vetro—s'innalzeranno al sole ed in questi apparecchi trasparenti si compiranno quei processi fotochimici di cui fino allora le sole piante avevano il segreto ed il privilegio, ma che l'industria umana avrà saputo carpire: essa saprà farli ben altrimenti fruttare perchè la natura non ha fretta mentre l'umanità è frettolosa. E se giungerà in un lontano avvenire il momento in cui il carbone fossile sarà completamente esaurito, non perquesto la civiltà avrà fine: chè la vita e la civiltà dureranno finchè splende il sole! E se anche alla civiltà del carbone, nera e nervosa ed esaurientemente frettolosa dell'epoca nostra, dovesse fare seguito quella forse più tranquilla dell'energia solare non ne verrebbe un gran male per il progresso e la felicità umana.

La fotochimica dell'avvenire non deve peraltro essere riserbata a si lontana scadenza: io credo che l'industria farà cosa assennata giovandosi anche presentemente di tutte le energie che la natura mette a sua disposizione: finora la civiltà moderna ha camminato quasi esclusivamente coll'energia solare fossile, mon sarà conveniente utilizzare meglio anche quella attuale?

THE PHOTOCHEMISTRY OF THE FUTURE

Giacomo Ciamician, Bologna.

(Translation supplied by the author)

Modern civilization is the daughter of coal for this offers to mankind the solar energy in its most concentrated form: that is in a form in which it has been accumulated in a long series of centuries. Modern man uses it with increasing eagerness and thoughtless prodigality for the conquest of the world and, like the mythical gold of the Rhine, coal is to-day the greatest source of energy and wealth.

The earth still holds enormous quantities of it, but coal is not inexhaustible. The problem of the future begins to interest us and a proof of this may be seen in the fact that the subject was treated last year almost at the same time by Sir William Ramsay before the British Association for the Advancement of Science at Portsmouth and by Prof. Carl Engler before the Versammlung deutscher Naturforscher und Aerzte at Karlsruhe. According to the calculations of Prof. Engler Europe possesses to-day about 700 billion tons of coal and America about as much; to this must be added the coal of the unknown parts of Asia. The supply is enormous but, with increasing consumption, the mining of coal becomes more expensive on account of the greater depth to which it is necessary to go. It must therefore be remembered that in some regions the deposits of coal may become practically useless long before their exhaustion.

Is *fossil* solar energy the only one that may be used in modern life and civilization? That is the question.

Sir William Ramsay has made a very careful study of the problem from the English point of view. He has considered the various sources of energy such as the tides, the internal heat of the earth, the heat of the sun, water power, the forests and even atomic disintegration, and has come to the conclusion that none can be practically used in England on account of her special contour and climate.

Though the internal energy of the earth may produce terrible disasters through volcanic eruptions and earthquakes, it can hardly be used by man. The energy derived from the rotation of the earth (tides) can hardly be counted upon on account of the enormous quantities of water that would have to be handled. Atomic disintegration has recently been treated in a brilliant lecture by Frederick Soddy, with special reference to the enormous energy changes which are involved. If man ever succeeds in availing himself of the internal energy of the atoms, his power will surpass by far the limits assigned to it today. At present he is limited to the use of solar energy. Let us see however whether the *actual* energy may not supplant that stored up in fossil fuel. Assuming that the solar constant is three small calories a minute per square centimeter, that is thirty large calories a minute per square meter or about 1800 large calories an hour. We may compare this quantity of heat with that produced by the complete combustion of a kilogram of coal, which is 8000 calories. Assuming for the tropics a day of only six hours sunshine we should have, for the day, an amount of heat equivalent to that furnished by 1.35 kg. of coal, or one kilogram in round numbers. For a square kilometer we should have a quantity of heat equivalent to that produced by the complete combustion of 1000 tons of coal. A surface of only 10,000 square kilometers receives in a year, calculating a day of only six hours, a quantity of heat that corresponds to that produced by the burning of 3650 million tons of coal, in round numbers three billion tons. The quantity of coal produced annually (1909) in the mines of Europe and America is calculated at about 925 million tons and, adding to this 175 million tons of lignite, we reach 1100 million tons or a little over one billion. Even making allowances for the absorption of heat on the part of the atmosphere and for other circumstances, we see that the solar energy that reaches a small tropical county—say of the size of Latium—is equal annually to the energy produced by the entire amount of coal mined in the world! The desert of Sahara with its six million square kilometers receives daily solar energy equivalent to six billion tons of coal!

This enormous quantity of energy that the earth receives from the sun, in comparison with which the part which has been stored up by the plants in the geological periods is almost negligible, is largely wasted. It is utilized in waterfalls (white coal) and by plants. Several times its utilization in a direct form through mirrors has been tried, and now some very promising experiments are being made in Egypt and in Peru; but this side of the problem is beyond my power to discuss and I do not propose to treat it here.

The energy produced by water power during the period of one year is equal to that produced by 70 billion tons of coal according to the data given in Professor Engler's lecture. It is however very small, as might be expected, in comparison with the total energy that the sun sends to the earth every year. Let us now see what quantity of solar energy is stored by the plants: on the total surface of the various continents, which is 128 million square kilometers, there is a yearly production of 32 billion tons of vegetable matter, which, if burnt, would give the quantity of heat that corresponds to the total combustion of 18 billion tons of coal. It is not much but even this is 17 times as much as the total present production of coal and of lignite.

I

Now let us consider the first part of our subject. Is it possible or, rather, is it conceivable that this production of organic matter may be increased in general and intensified in special places, and that the cultivation of plants may be so regulated as to make them produce abundantly such substances as can become sources of energy or be otherwise useful to civilization? I believe that this is possible. It is not proposed to replace coal by organic substances produced by plants; but it is conceivable that this organic matter may be utilized more satisfactorily than is now the case.

It has frequently been said even by persons of authority that some day the transformation of coal into bread may become not only possible but economically desirable. According to these people the ideal of the future should be to produce through synthesis from coal all substances necessary for the alimentation of man: such substances as starch, sugar and fat, also proteins and perhaps cellulose; in other words to abolish agriculture altogether and to transform the world in to a garden of useless flowers. Never was a greater fallacy thought or expressed: the real problem is just the reverse of this. My friend Professor Angeli wisely called to my attention that, while the externals of life have been changed greatly by the progress of industry so as to use all our technical knowledge to increase our comfort, the quality and quantity of human alimentation have hardly changed at all; nay, a new science has come into existence (bromatology) to see that no artificial product of industry enters harmfully into our alimentation. At the time of Napoleon III an attempt was made to substitute gelatine for meat; but it was seen very soon—and now the reason for it is known by all—that this substitute could not be sufficient to maintain life. With the relatively small reserves of coal that the past geological epoch have stored for us, it will never be desirable to produce from coal what nature generously offers us through solar energy. It is on the other hand a work worthy of praise to attempt to make plants produce the fundamental substances in larger quantity. Modern agriculture tries to do this by intensive cultivation; but it is also desirable to make the plants store up solar energy and transform it into mechanical energy.

A well-known instance of this occurred when the development of the daily press in all civilized countries made it imperative to provide wood pulp in a sufficient quantity and at low prices. Trees, better adapted to the purpose, were soon found and they were those which, on account of their rapid growth, could furnish the necessary cellulose sooner. For the problem we are now considering the quality of the plants is of secondary importance; they may be herbs or trees; they may grow in swamps or dry places, on the sea coast or even in the sea; the essential point is that they grow fast or that their growth may be intensified. It would be like realizing the desire of Faust:

"Und Bäume die sich täglich neu begrünen!"

Mephistopheles did not consider a similar task impossible:

"Ein solcher Auftrag schreckt mich nicht,
Mit solchen Schätzen kann ich dienen."

Should we consider the task impossible, naturally in a more limited sphere, after so many centuries of culture? I do not believe so. The above estimate of the total production of organic matter over all the solid surface of the earth, that is of 32 billion tons a year, has for its basis the old calculation of Liebig of 2.5 tons per hectare. This may be considered even to-day the average production for all the earth. According to A. Mayer, through instenified culture the production may be increased to 10 tons per hectare and in tropical climates it may reach 15 tons. On a square kilometer it would be 1500 tons, corresponding to 840 tons of coal, while the solar energy received in a year by a square kilometer would be equivalent to about 300,000 tons of coal, the part of the total energy stored up by the plants being about $\frac{1}{300}$. A great deal remains to be done, but if we consider that since Liebig, largely by adopting the methods proposed by him, the production has been at least quadrupled, we may hope to do much more in the future, especially if we are spurred on by necessity or even by convenience.

By increasing the concentration of carbon dioxide up to an optimum value (1 to 10% according to Kreusler) and by using catalyzers, it seems quite possible that the production of organic matter may be largely increased, making use, of course, of suitable mineral fertilizers and selecting localities adapted to the purpose owing to the climate or the condition of the soil. The harvest, dried by the sun, ought to be converted, in the most economical way, entirely into gaseous fuel, taking care during this operation to fix the ammonia (by the Mond process for instance) which should be returned to the soil as nitrogenous fertilizer together with all the mineral substances contained in the ashes. We should thus get a complete cycle for the inorganic fertilizing substances, the only waste being that common to all industrial processes. The gas so obtained should be burnt entirely on the spot in gas engines and the mechanical energy thus generated should be transmitted elsewhere or utilized in any way that seems advisable. We need not go into details. The carbon dioxide, resulting from the combustion, should not be wasted but should be returned to the fields. Thus the solar energy, obtained by rational methods of cultivation, might furnish low-priced mechanical energy, perhaps better than through the systems based on mirrors, because the plants would be the accumulators of the energy received by the earth.

But the problem of the utilization of plants in competition with coal has another and more interesting side. First of all we must remember the industries which have their basis in agriculture: the cotton and other textile industries, the starch industry, the production of alcohol and of all fats, the distillation of wood, the extraction of sugar, the production of tanning substances and other minor industries. All these industries are susceptible of improvement not only by the introduction of more advantageous technical devices in the treatment of the raw materials but also by a largely increased production of the raw materials. Let us think for an example of the progress made in the production of beet sugar.

The plants are unsurpassed masters of—or marvellous workshops for—photochemical synthesis of the fundamental substances, building up from carbon dioxide with the help of solar energy. They also produce the so-called secondary substances with the greatest ease. These latter are usually found in the plants in small quantity and are of value for special reasons. The alkaloids, glucosides, essences, camphor, rubber, coloring substances and others are of even greater interest to the public than the fundamental substances on account of their high commercial value. In this field a battle is raging between chemical industry and nature, a battle which does honor to human genius. Up to now the products prepared from coal tar have almost always been triumphant. I do not need to remind you of the various victories; but it is possible that these may prove to have been Pyrrhic victories. A great authority on organic industries considered recently what would happen in case, for any reason, there were a rapid increase in the price of coal tar and consequently of the substances contained in it. He pointed out the inevitable effect of this on the coal tar industries. We all remember with admiration the story of the great difficulties that had to be met in the choice of the raw material for the production of indigo. It was necessary finally to use naphthalene because toluene could not be obtained in sufficient quantity. But it is not merely through a rise in the price of the raw materials that an industry may suffer; it may be brought to a standstill by a diminished interest and activity in a certain field of scientific study. It has been thoroughly established that modern industry is affiliated very intimately with pure science; the progress of one determines necessarily that of the other. Now the chemistry of benzene and its derivatives does not constitute the favorite field of research as it did during the second half of the last century. The centre of interest is now to be found in the matters and problems connected with biology. Modern interest is concentrated on the study of the organic chemistry of organisms. This new direction in the field of pure science is bound to have its effect on the technical world and to mark out new paths for the industries to follow in the future.

It is a fact that lately several organic industries have been successfully developed, outside of the field of benzene and coal tar. There are flourishing industries in essences and perfumes and in some alkaloids, like coca. In these industries products, which plants produce in relatively large amounts, are converted into products of higher commercial value. For instance everybody knows that essence of violet is now made from citral contained in lemon oil. This is a line along which we ought to follow because we are certain of making progress. It is to be hoped that in the future we may obtain rubber commercially in some such way.

The question has still another side, which I believe deserves your attention; it concerns certain experiments recently made by myself together with Professor Ravenna at Bologna. It is not because we have arrived at any practical results that I refer to these experiments; but because they show definitely that we can modify to a certain extent the chemical processes that take place during the life of the plants. In a series of experiments made in an effort to determine the physiological function of the glucosides, we have succeeded in obtaining them from plants that usually do not produce them. We have been able, through suitable inoculations, to force maize to synthesize salicine. More recently, while studying the function of the alkaloids in the plants, we have succeeded in modifying the production of nicotine in the tobacco plant, so as to obtain a large increase or a decrease in the quantity of this alkaloid. This is only a beginning, but does it not seem to you that, with well-adapted systems of cultivation and timely intervention, we may succeed in causing plants to produce, in quantities much larger than the normal ones, the substances which are useful to our modern life and which we now obtain with great difficulty and low yield from coal tar? There is no danger at all of using for industrial purposes land which should be devoted to raising foodstuffs. An approximate calculation shows that on the earth there is plenty of land for both purposes, especially when the various cultivations are properly intensified and rationally adapted to the conditions of the soil and the climate. This development is the real problem of the future.

II

Technical organic industry may yet expect great help from photochemistry understood in the sense above expressed and the competition between this and the chemistry of coal tar will be a great incentive for new progress. It is also true that human genius will always tend to proceed along lines selected by itself, and there is no question but that the great development in the coal tar industry has been due in part to this splendid spirit of independence. It may be asked whether there are not other methods of production which may rival the photochemical processes of the plants. The answer will be given by the future development of photochemistry as applied to the industries and on this I have a few ideas to express. The photochemical processes have not had so far any extensive practical application outside of the field of photography. From its very beginning photography has aroused a great deal of interest; it was taken up technically and, as usually happens in similar cases, it had a rapid and brilliant success. But notwithstanding the many applications photography represents only a small part of photochemistry. So far, photochemistry has only been developed to a very slight extent, perhaps because chemists have been attracted by problems which seemed more urgent. So it happens that while thermochemistry and electrochemistry have already reached a high degree of development, photochemistry is still in its infancy. Now, however, we notice a certain awakening due to a series of studies concerning general problems and special processes, especially in the organic field, in which my friend Dr. Paul Silber and myself have taken an active part. Two recent publications, one by Plotnikow and the other by Benrath bear witness to this. But much remains to be done both in theoretical and general photochemistry as well as in the special branches.

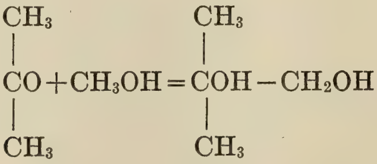
The photochemical reactions follow the fundamental laws of affinity, but have a special character. They are especially notable for the small temperature coefficient and are, however, comparable—a fact which is not without technical importance—to the reactions which take place at very high temperatures. According to a brilliant idea of Plotnikow, luminous radiations produce a different ionization from that due to electrolytic dissociation; the separation of an ion requires a quantity of light which is determined by the theory of Planck and Einstein. The question is therefore related to the most recent and profound speculations of mathematical physics.

For our purposes the fundamental problem from the technical point of view is how to fix the solar energy through suitable photochemical reactions. To do this it would be sufficient to be able to imitate the assimilating processes of plants. As is well known, plants transform the carbon dioxide of the atmosphere into starch, setting free oxygen. They reverse the ordinary process of combustion. It has always seemed probable that formaldehyde was the first product of the assimilation; and Curtius has at last demonstrated its presence in the leaves of the beech trees. The artificial reproduction of a similar process by means of ultraviolet rays has already been obtained by D. Berthelot. With convenient modifications could not this now actually be done on the tropical highlands? Yet the true solution consists in utilizing the radiations that pass through the entire atmosphere and reach the surface of the earth in large amounts. That a way of accomplishing this exists is proved by the plants themselves. By using suitable catalyzers, it should be possible to transform the mixture of water and carbon dioxide into oxygen and methane, or to cause other endo-energetic processes. The desert regions of the tropics, where the conditions of the soil and of the climate make it impossible to grow any ordinary crops would be made to utilize the solar energy which they receive in so large a measure all the year, that the energy derived from them would be equal to that of billions of tons of coal.

Besides this process, which would give new value to the waste products of combustion, several others are known, which are caused by ultraviolet radiations and which might eventually take place under the influence of ordinary radiations, provided suitable sensitizers were discovered. The synthesis of ozone, of sulphur trioxide, of ammonia, of the oxides of nitrogen, as well as many other syntheses, might become the object of industrial photochemical processes.

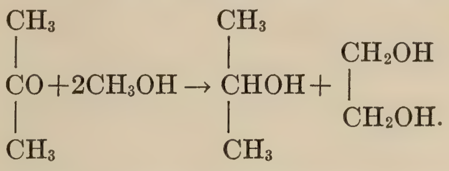
It is conceivable that we might make photoelectrical batteries or batteries based on photochemical processes, as, for instance, in the experiments of C. Winther.

Passing to the field of organic chemistry, the reactions caused by light are so many that it should not be difficult to find some which are of practical value. The action of light is especially favorable to processes of reciprocal oxidation and reduction which give rise to or are associated with phenomena of condensation. Since the common condensation is that of the aldolic type there is much hope for the future, the aldolic condensation being the fundamental reaction of organic synthesis. Some experiments recently made by my friend Silber and by myself may serve here as an illustration. The simplest case is that of the action of light on a mixture of acetone and methyl alcohol in which



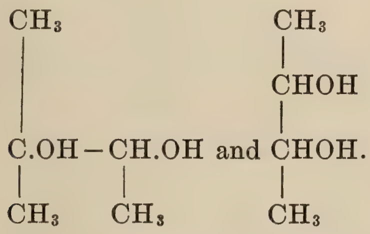
$$\begin{array}{llll} \mathrm{CH_3} & & \mathrm{CH_3} & \\ | & & | & \\ \mathrm{CO} & +\mathrm{CH_3OH}= & \mathrm{COH} & -\mathrm{CH_2OH} \\ | & & | & \\ \mathrm{CH_3} & & \mathrm{CH_3} & \end{array}$$

isobutylene glycol is produced. But this condensation which may be considered as a simultaneous process of oxidation and reduction, is accompanied by the reduction of the ketone to isopropyl alcohol and by the oxidation of the methyl alcohol to formaldehyde, which latter, however, does not remain as a product which can be isolated because it reacts with the remaining methyl alcohol and is transformed into ethylene glycol:



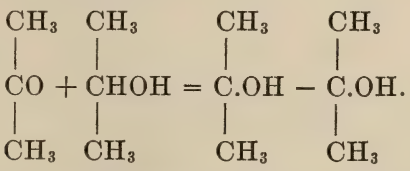
$$\begin{array}{c}CH_3\\|\\CO\\|\\CH_3\end{array} + 2CH_3OH \rightarrow \begin{array}{c}CH_3\\|\\CHOH\\|\\CH_3\end{array} + \begin{array}{c}CH_2OH\\|\\CH_2OH.\end{array}$$

Applying the same photochemical reaction to the mixture of acetone and ethyl alcohol we have analogous products: trimethylethylene glycol; and along with this isopropyl alcohol and dimethylethylene glycol:



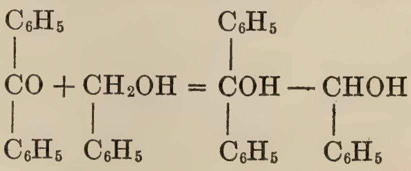
$$\begin{array}{ll}CH_3 & \\ | & \\ C.OH - & CH.OH \\ | & | \\ CH_3 & CH_3\end{array} \text{ and } \begin{array}{c}CH_3\\|\\CHOH\\|\\CHOH.\\|\\CH_3\end{array}$$

With acetone and isopropyl alcohol, as could be expected, there is formed only pinacone:



$$\begin{array}{c}CH_3\\|\\CO\\|\\CH_3\end{array} + \begin{array}{c}CH_3\\|\\CHOH\\|\\CH_3\end{array} = \begin{array}{c}CH_3\\|\\C.OH\\|\\CH_3\end{array} - \begin{array}{c}CH_3\\|\\C.OH.\\|\\CH_3\end{array}$$

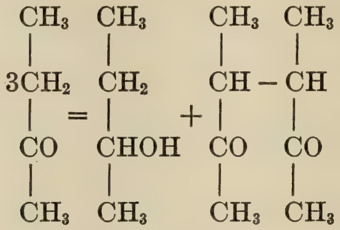
In the aromatic series benzophenone and benzyl alcohol give triphenylethylene glycol, together with other products:



$$\begin{array}{c}C_6H_5\\|\\CO\\|\\C_6H_5\end{array} + \begin{array}{c}CH_2OH\\|\\C_6H_5\end{array} = \begin{array}{c}C_6H_5\\|\\COH\\|\\C_6H_5\end{array} - \begin{array}{c}CHOH\\|\\C_6H_5\end{array}$$

This was the first case in which this condensation has been observed; others were afterwards studied by Paternò, who replaced the benzyl alcohol by several other aromatic substances. The observations of Klinger showed that the aldehydes also underwent condensations and this has since been confirmed by Benrath.

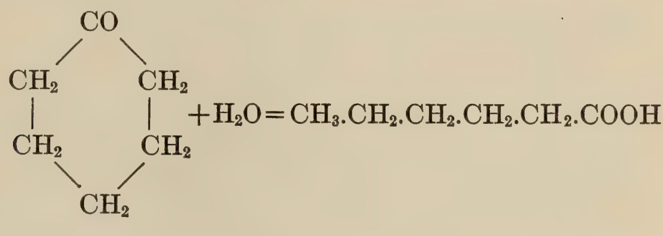
To get an idea of the variety of photochemical reactions we may confine ourselves to a systematic study of the ketones and alcohols. In ordinary organic chemistry the reactions often take place in some definite way; but the photochemical reactions often furnish surprises and proceed along quite different lines. From the very first experiments we knew that benzophenone did not form addition products with ethyl alcohol, but was converted into pinacone at the expense of the alcohol, which was oxidized to aldehyde. Proceeding with the study of aliphatic ketones, similar to acetone, we have this year discovered a remarkable fact. Methylethylketone condenses with itself and forms the paradiketone, reducing itself at the same time to secondary butyl alcohol:



$$\begin{array}{cccccccc}
 & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3}\\
 & | & & | & & | & & |\\
3 & \mathrm{CH_2} & & \mathrm{CH_2} & & \mathrm{CH} & - & \mathrm{CH}\\
 & | & = & | & + & | & & |\\
 & \mathrm{CO} & & \mathrm{CHOH} & & \mathrm{CO} & & \mathrm{CO}\\
 & | & & | & & | & & |\\
 & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3} & & \mathrm{CH_3}
\end{array}$$

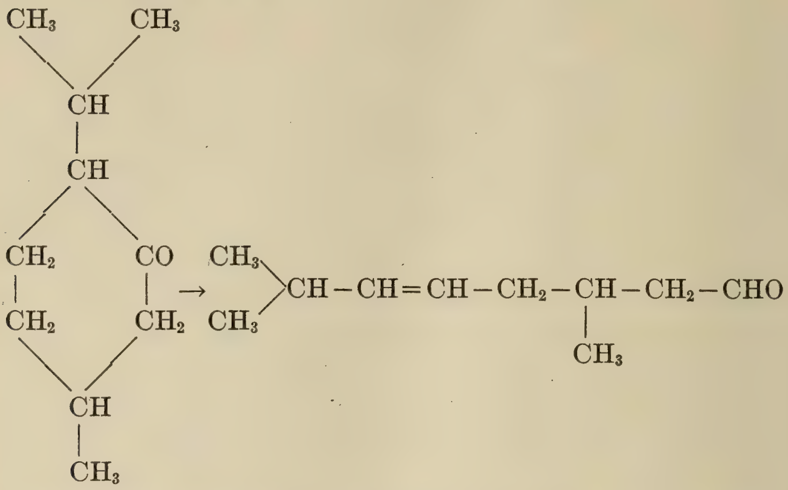
Of course the synthesis of diketones by light could not be an isolated reaction; we had previously noticed the formation of diacetyl: acetonylacetone is found, as we now know, among the products of acetone in solution in ethyl alcohol and it is also possible that the metadiketones, such as acetylacetone for instance, may be prepared photochemically. These reactions have a special importance on account of the special character of the diketones and their tendency to change in all sorts of ways. From them derivatives of benzene can be obtained as well as of pyrrazol and isoxazol, of quinoline, of furfurol, of thiophene and of pyrrol. In regard to this last change I wish to remind you that tetramethylpyrrol corresponds to the paradiketone previously referred to. If I dare to be reckless, as you may see I am at this moment, contrary to my custom, but perhaps urged thereto unconsciously by the American genius which heeds no obstacles, I may refer to the relations between the polysubstituted pyrrols with alcohol radicals and chlorophyll, and I may see in these reactions the possibility of the synthesis of this fundamental substance by means of an artificial photochemical process. Its formation in plants, like its function, is due to a photochemical process; we do not know, however, whether and in what measure light enters into all the synthetic plant reactions, from which originate the various substances which we find in plants. The research should proceed together in the two fields; phytochemistry and photochemistry will be of great help one to another. Industrially this co-operation might have a great future: the raw materials obtained from the plants might be refined through artificial photochemical processes.

Lately we have been interested intensely by the changes that some substances of the group of the terpenes and of the camphors undergo when exposed to light, especially through hydrolytic processes. So far, indeed, our experiments have taught us that light can spoil rather than improve essences. The cycloketones, for instance, are hydrolized and give the corresponding fatty acids; the cycloesanone gives capronic acid and menthone gives decylic acid.

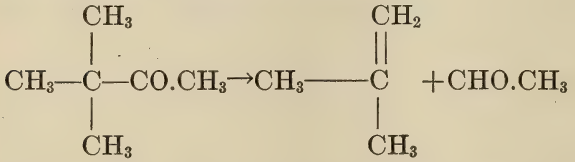


$+H_2O=CH_3.CH_2.CH_2.CH_2.CH_2.COOH$

In photochemistry, however, one reaction does not exclude the other; the reactions may be reversed as some recent experiments with ultraviolet rays demonstrate; for the ultraviolet rays sometimes reverse reactions caused by less refrangible radiations. It is important to find suitable sensitizers and catalyzers. We can see what the future has in store for us from such reactions as the photolysis of the ketones, which often accompanies the hydrolysis, and by means of which we prepare isocitronellal, for instance from menthone,



or the transformation of camphor into an unsaturated cycloketone, etc. The analogous breaking down of pinacoline into butylene and acetic aldehyde



$$CH_3—\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}—CO.CH_3 \rightarrow CH_3——\overset{\displaystyle CH_2}{\underset{\displaystyle CH_3}{\overset{\|}{\underset{|}{C}}}} \quad + CHO.CH_3$$

is remarkable because it demonstrates what violent decompositions light may cause. It may be an enemy, but just on account of that it is necessary to be familiar with the weapons of the adversaries in order to be able to conquer them and to avail ourselves of their strength.

I do not believe, however, that the industries should wait any longer before taking advantage of the chemical effects produced by light. The polymerizations, the isomeric changes, the reductions and oxidations with organic and inorganic substances, and the autoxidations which light causes so easily should already find profitable applications in some industries if researches were carried out carefully with this in mind. The action of light on nitric and nitrosilicic compounds, as we know it from experience, is one that ought to be utilized profitably. Our own transformation of orthonitrobenzoic aldehyde into nitrosobenzoic acid has recently has been studied by various chemists, and has been made use of by Pfeiffer, who prepared a nitrophenylisatogen from chlorodinitrostilbene. This reminds us of the not less known transformation of benzylidene orthonitroacetophenone into indigo by Engler and Dorant and makes us foresee a new field in the photochemical production of artificial colors and dye-stuffs. The scope of studies on this subject ought not to be limited to preserving colors from fading, bleaching and all changes produced by light. The photochemistry of colors and dye-stuffs ought to furnish new methods of preparation and of dyeing. Very encouraging experiments have already been made with diazoic compounds and mention should be made of the recent observation of Baudisch that α-nitrosonaphthylhydroxylamine is changed on the fibre to azoxynaphthalene when exposed to light. The autoxidation of leuco compounds by light is an old practice of which the ancients availed themselves for preparing purple; now the process is explained, thanks to the familiar researches of Friedländer, but it is clear that a great deal remains to be learned in this field.

Phototropic substances, which often assume very intense colors in the light, and afterwards return in the darkness to their primitive color, might be used very effectively. Such substances might well attract the attention of fashion rather than fluorescent materials which give the impression of changing colors. The dress of a lady, so prepared, would change its color according to the intensity of light. Passing from darkness to light the colors would brighten up, thus conforming automatically to the environment: the last word of fashion for the future.

Solar energy is not evenly distributed over the surface of the earth; there are privileged regions, and others that are less favored by the climate. The former ones would be the prosperous ones if we should become able to utilize the energy of the sun in the way which I have described. The tropical countries would thus be conquered by civilization which would in this manner return to its birth-place. Even now the strongest nations rival each other in the conquest of the lands of the sun, as though unconsciously foreseeing the future.

Where vegetation is rich, photochemistry may be left to the plants and by rational cultivation, as I have already explained, solar radiation may be used for industrial purposes. In the desert regions, unadapted to any kind of cultivation, photochemistry will artificially put their solar energy to practical uses.

On the arid lands there will spring up industrial colonies without smoke and without smokestacks; forests of glass tubes will extend over the plains and glass buildings will rise everywhere; inside of these will take place the photochemical processes that hitherto have been the guarded secret of the plants, but that will have been mastered by human industry which will know how to make them bear even more abundant fruit than nature, for nature is not in a hurry and mankind is. And if in a distant future the supply of coal becomes completely exhausted, civilization will not be checked by that, for life and civilization will continue as long as the sun shines! If our black and nervous civilization, based on coal, shall be followed by a quieter civilization based on the utilization of solar energy, that will not be harmful to progress and to human happiness.

The photochemistry of the future should not however be postponed to such distant times; I believe that industry will do well in using from this very day all the energies that nature puts at its disposal. So far, human civilization has made use almost exclusively of fossil solar energy. Would it not be advantageous to make better use of radiant energy?

In moving a vote of thanks to Commanditore Ciamician for his lecture Professor W. D. Bancroft said:—

From the general lectures which we have been privileged to hear at this Congress, we have learned much of the marvels of modern synthetic chemistry. We know that in many respects the laboratory of the chemist is more efficient than the laboratory of nature. The chemist can make indigo of better quality than the plant, and at a cheaper price. We know that the chemist can now make synthetic rubber of a better quality than that produced by the tree; and we hope that before long he will be able to make it at a cheaper price. But, while the chemist can compete with the laboratory of nature in many respects, there are others in which he cannot. The plant produces its voluble products with a calm equanimity and tranquillity which as yet the chemist cannot rival. The reason for that is that the plant is a photo-chemist, or an expert in photo-chemistry, while man as yet has only dabbled in the subject.

When I was young I was told to "Go to the ant thou sluggard," but as I read it, the lesson of today is "Go to the plant, thou chemist."

I have heard from the speaker of today of the marvels that will take place when man has learned the secrets of the plants. What has been outlined to you is a beautiful dream today, but it is a dream that will come true in the future; and it seems to be specially significant that this inspiring and prophetic lecture should have been delivered by an Italian. We learned from Galileo that the earth moved. We learned from Allesandro Volta of the chemical transformations that can be produced by electrical energy—electricity, and we have learned today from Giacomo Ciamician of the marvels that will take place when man can convert solar energy direct into chemical energy.

Professor, it gives me great pleasure to move you a vote of thanks.

Dr. Leo H. Baekeland in seconding Professor Bancroft's motion said:

Our distinguished Italian fellow-chemist has given us a glimpse of the vision of the future. I was thinking all the time that how, after all, we chemists, with all our pretensions, make rather a clumsy job of our work. Lately we have had the pretension of trying to imitate nature. In order to do that we boil, we distill, we heat, we use strong electric currents. Nature does nothing of the kind. We are using means which are only murdering substances. We are trying to imitate those simple things which happen in the plant, and we are trying to imitate them in about the same way as you would imitate the beautiful melodious music of Italian composers by exploding a cartridge of dynamite in the interior of the organ. And those words of a fellow-chemist show us the way to accomplish those difficulties in chemistry which have not been carried out until now. The photo-chemist of today is still making pictures. His grasp on the situation does not go beyond mere trifles. The day will come when photochemistry will be just as important, and more important than electro-chemistry; and therefore I take great pleasure in seconding the motion made by Professor Bancroft in tendering our distinguished Italian fellow-chemist a vote of thanks that he has been kind enough to give us an inspiration from the Land of the Sun.

The motion was carried unanimously amid great applause.

THE JOINT SESSIONAL ADDRESSES

These were two in number and were held before Joint Sessions of the Sections on Inorganic Chemistry, Agricultural Chemistry, Electro-chemistry and Physical Chemistry.

The first was by Samuel Eyde of Christiania and delivered by him in the Auditorium of the American Museum of Natural History in New York City on Saturday, September 7, 1912; the second was by H. A. Bernthsen of Ludwigshafen and delivered by him in the Horace Mann Auditorium in New York City on Wednesday, September 11, 1912.

The text of these Joint Sessional Addresses follows:

Oxidation of Atmospheric Nitrogen and Development of Resulting Industries in Norway.

SAMUEL EYDE

We all know that the atmosphere surrounding us is composed of nitrogen and oxygen; to create by the union of these two elements new chemical combinations that can be utilized in the world's household is the task of the new industry.

I regret that the time and the present occasion do not permit me to pass in review all the experiments made by pre-eminent men on the solution of this problem; I must confine myself to what has been done in Norway.

More than one hundred years ago (1784), I may mention, Priestley and Cavendish observed that the oxidation of atmospheric nitrogen took place slowly under the action of such electric discharges as were then available, and men like Sir William Crookes and Lord Rayleigh and Sir William Ramsay have, with others in recent years, given valuable contributions to the subject. With respect to later experiments, before those of Birkeland and Eyde, which are of a more practical nature, the work which Lovejoy and Bradley have done should be mentioned as very important. Time will not permit entering into the details of the various systems. In briefly describing the difference between previous methods and that of Birkeland-Eyde, it must suffice to say that the later have applied large quantites of electric energy in the electric arc, and have discovered the best method of doing this, while it was previously believed that it was small quantities of energy that gave relatively the best results.

It is on that assumption that the apparatus employed by them was constructed.

In order to explain the Birkeland-Eyde method, it is necessary first to describe the electric flames consisting of arcs of light, which are used in the electric furnaces.

The formation of the flame occurs by an arc of the electric flame being formed between the points of the electrodes, which are close to each other. By this means a movable and flexible current is established in a highly magnetic field. The electric arc that has been formed moves on account of this magnetic field with great velocity perpendicularly to the lines of force, and the electric arc's foot draws back from the points of the electrodes. When the length of the electric arc increases the electric resistance becomes greater and the tension increases, until it becomes so great that the new electric arc starts from the points of the electrodes.

To regulate the current, an inductive resistance is used in series with the flame. With alternating current all the arcs are formed alternating in opposite directions and appear to the eye to be circular discs. This flame provides a powerful technical means for the oxidation of the nitrogen of the air. The flame in our furnaces burns with a steadiness that is really astonishing.

The electrodes are thick copper tubing, through which water passes for cooling purposes. The chamber in which the flame burns is circular, of only a few centimeters in width, and about three metres in diameter.

The interior of the furnaces is lined with fire clay brick, through the walls of which the air is admitted to the flame. The nitrous gases formed in the flame escape through a channel made along the casing of the furnace, which, like the flame chamber, is furnished with fireproof bricks.

In order to supply the furnace with the amount of power desired, each one is furnished with an induction coil, by means of which the power is regulated as required. The induction coil serves, moreover, to keep the flame in the furnace steady and even while working.

With this furnace we have obtained such a steady working that it burns for weeks without any regulation worth mentioning. It may further be stated that the maintenance of the furnace and its repair are simple, as the most exposed portions, the electrodes, need be changed every third or fourth week, and then only a small part of them. The fireproof masonry is changed every fourth to sixth month.

The temperature in our flames exceeds 3,000° C. The temperature of the escaping gases may vary between 800° and 1,000°. The furnaces are made of cast steel and iron, the middle of the furnace being in the form of a circular flame chamber. The electrodes are led radially into this flame chamber. By aid of centrifugal fans the air is brought into each furnace through tubes from the basement.

From furnaces which consumed an energy of some few horsepower, we have attained to types which can, as mentioned, take an energy of more than 5,000 h. p.

We have in course of the development of our method had four experimental stations.

Some years after the perfection of our furnace, Dr. Schoenherr, with the electrical engineer Hessberger, of the Badische Company, perfected an electric furnace for the oxidation of atmospheric nitrogen which is constructed on quite different principles.

In place of the great disc of electric flame he developed along slender arc in the axis of a narrow iron tube through which a current of air is forced.

The type now used consists of a somewhat slender vertical column of iron plates 7 metres in height. The inner tube is the reaction chamber, the others form channels for the entrance of the air current and its exit after coming in contact with the flame. In this way the heat of the outgoing gas is transferred to the ingoing current.

At the lower end is the main electrode which is movable in a vertical direction, as it must be raised from time to time when the end is worn away by the arc.

The reaction tube serves as the second electrode. By means of a lever the space between the electrode and tube can be bridged over and the arc formed.

The air current forced by a powerful aspirator enters in the lower part of the furnace and passes the channels. The entry into the reaction chamber is through a number of small tangentia openings arranged in several horizontal rows in the sides. The current passes in this way around the chamber and the arc is driven up in the midst of the rapidly moving current of air.

As a rapid cooling is of importance in securing a good yield the upper third of the tube has a water jacket through which the gases pass, and in this way the reverse reaction is prevented to a notable degree.

The reaction is identical with that obtained in the Birkeland-Eyde furnace, and the yield, as far as the results now obtained is practically the same.

I will describe the process and give you some details of the various parts of the factory.

The air for the furnaces is procured by swiftly revolving ventilators, and is conducted through large iron pipe lines to the furnaces.

At Notodden we have only furnaces of the Birkeland Eyde system, from 1,000 to 3,000 kw. capacity.

At Rjukan there are, however, furnaces of the Birkeland:Eyde system of 3,000 kw. as well as furnaces of the Schönherr system, all of 1,000 kw.

When the air in the flame chamber has been acted upon by the electric flame the nitrous gases formed pass out through pipes, which convey the gas to the steam boilers, in which the temperature, which was 1,000° C., is reduced.

The steam produced in the boilers is utilized in the further treatment of the products. In the boiler house there are also air compressors, which supply compressed air for pumping acid and lye in the various chemical departments.

The gases pass on from the steam boilers through an iron pipe into the cooling house, and complete the cooling begun in the steam boilers.

Each cooler consists of a great number of aluminum tubes, over which cold water runs, while the hot gases pass through them. The temperature of the gas is considerably reduced. From the cooling chambers the gases pass to the oxidation tanks.

These oxidation tanks are vertical iron cylinders, lined with acid proof stone. The object is to give the cooled gases a sufficient period of repose, in which time the oxidation of the nitrogen oxide may occur. The necessary amount of oxygen is present in ample quantity in the air which accompanies the gases from the furnaces. From the oxidation tanks the gases by blast engines are led into the absorption towers.

The towers are filled with broken quartz, which is neither affected by nitrous gases nor by nitric acid. To assist the passage of the gases on their way from the furnaces there are centrifugal aluminum fans on each row of towers.

The gases enter at the base of the first tower, go up through the quartz packing and thence by a large earthenware pipe enter the top of another tower, through which they pass downwards through the quartz to the bottom of the third tower, and so on, until the air, relieved of all nitrous gases, leaves the blast tower. Water trickles through the granite towers, and this is gradually converted into a weak nitric acid, while the liquid used in the iron towers is a solution of soda. The absorbing liquid enters the top of the tower and is distributed in jets by a series of earthenware pipes, so that the permeating gases enter into immediate contact with the absorbing liquid. Nitric acid is thus formed in the granite towers and in the iron towers a solution of nitrite of soda.

The liquid emerges in a constant even stream from the bottom of the towers, running into a granite cistern. It then flows in to the *montejus* which serve to pump up the acid, which has to pass repeatedly through the tower before it has become strong enough for the purpose for which it is intended. The *montejus* are worked by compressed air and send the acid up into large stoneware tanks. From these jars the acid again runs through the towers. The *montejus* work automatically.

The iron towers are percolated, as already mentioned, by a solution of soda, otherwise the whole process is practically similar to that in the granite towers. The solution of soda, owing to its far greater power of absorption, effects the separation of the last remaining traces of nitrogenous gases from the accompanying air. Of the entire quantity of nitrous gases passed through the absorption system, about 97% is absorbed. The finished nitric acid coming from the towers, which has a strength of about 30% by volume, is collected in granite cisterns, from which it is drawn to what is called the "dissolution works." These consist of granite vats filled with limestone, over which the acid is poured. This drives off, with violent effervescence, the carbonic acid of the limestone. The nitric acid takes its place and forms a watery solution of nitrate of lime or calcium nitrate. The rest of the acid is neutralized in small towers filled with milk of lime and is now pumped into vacuum evaporating apparatus. A great saving in heat is effected by boiling in vacuum.

The steam required for the evaporation is obtained from the steam boilers, heated, as before mentioned, by the furnace gases. The concentration of the nitrate solution in the evaporizing plant is continued until the specific weight of the liquid at an even temperature shows a content of 13% nitrogen. This solution is then sufficiently evaporated, and can be pumped up into the solidification chambers, where it is conducted upon a revolving cylinder, cooled on the inside. It then stiffens so rapidly that it will easily spring off into small leaf-like pieces, which can be granulated without difficulty in the crushing mill. There the mass is reduced to a granular state.

The coarse powder produced is raised by an elevator to a vat, from the bottom of which it is dumped into casks holding 100 kilos net weight.

The gas lead into the iron tower forms with the solution of caustic soda a solution of nearly pure sodium nitrite. This is concentrated by evaporation in the same sort of apparatus as above and allowed to crystallize. The crystals are dried in a centrifuge and put up in casks.

The barrels are made at our own cooper's shop and are lined with paper to guard against damp.

In addition to these two products, nitrate of lime and nitrite of soda, we have during the last years at our Notodden works taken up the manufacture of concentrated nitric acid and nitrate of ammonia, which products have already established themselves and are shipped in comparatively large quantities to the United States and other countries.

We are, however, not confined to the products mentioned. There are possibilities for the development of a series of new industries, as the nitric acid—our first product—is the basis of the manufacture of a great many products used in the industries and in agriculture.

We have worked out a process which may be of great value to the United States, namely a method for transforming raw phosphates into phosphate fertilizers. We have had an experimental factory running and the results have been most gratifying.

The process is, in brief outline: Raw phosphates which for the greater part consist of phosphoric acid combined with lime in the form of threecalcic phosphate, are treated with nitric acid. A solution containing monocalcic phosphate and nitrate of lime is the result. Out of this solution, in form of diphosphate, the phosphate is precipitated by adding lime to the solution. The diphosphate contains about 30% available phosphoric acid and, according to the treatment, more or less nitrogen in the form of nitrate of lime.

We are thus in the position to manufacture a product which contains phosphoric acid and nitrogen in the same proportion as used in the mixed fertilizers in the United States. The nitrogen industry is showing here new possibilities for the utilization of phosphate deposits and has in this country the brightest prospects for an excellent future.

Visitors to our factories are often under the impression that the works are not running at all. There is but little noise and workmen are hardly visible. It is remarkable indeed how few people are required to run the establishments. As a matter of fact comparatively large working forces are only needed in the packing and wrapping departments.

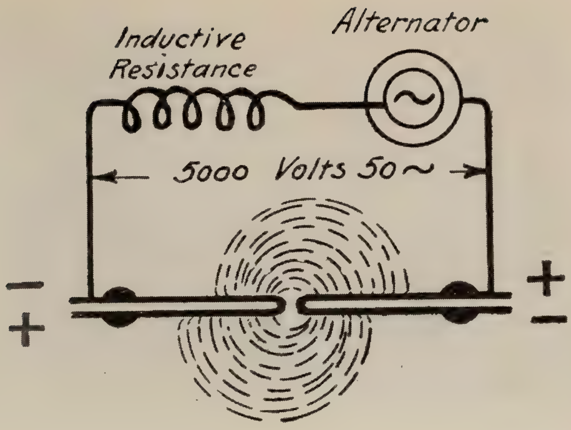
For the development of the atmospheric nitrogen industry the question of water power is a vital one. Hence the Norwegians have given this question as much attention as the chemical part of the manufacture. Our industry cannot exist unless it can procure cheap water power. But there is hardly a country in the entire world that can boast of more favorable conditions in this respect than Norway, and the enormous rise of our industry must be attributed to a very large extent to Norway's magnificent opportunities in the amount of water power available for manufacturing purposes. It must be borne in mind that Norway has not only her magnificent and high waterfalls but that she has large mountain lakes, permitting the construction of enormous natural reservoirs for conveying the water to the power stations. In our districts we enjoy most favorable conditions in this respect. The works now built are all situated in the southeastern part of Norway, in the Telemark river district.

The most important works, the Notodden nitrate factories, are admirably situated on the lake of Hiterdal, about 50 feet above the level. A short channel with a series of locks permits communication with the town of Skien, an important seaport at the head of the fjord. Under present conditions vessels of 200 tons burden can ascend to Notodden. It is planned to enlarge the locks so as to allow the passage of seagoing vessels of 2,000 tons. The ability to ship directly to all parts of the world by water, with one transhipment, is an important factor in the future of the Notodden nitrate industry.

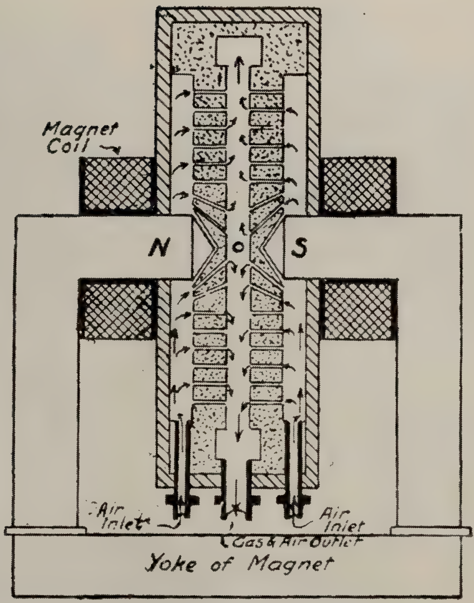
The Notodden factories, which now use about 60,000 h. p., secure their power from two neighboring waterfalls, Lienfos and Svaelgfos.

At Lienfos, about two miles from Notodden, a dam with a fall of about 55 feet was completed in 1911. The volume of water is 75 cubic metres per second. The power station is equipped with four units, of 5,000 h. p. each.

The Svaelgfos power house is situated above and about one mile from Lienfos. The volume of water is the same as at Lienfos. The dam has, however, a fall of about 165 feet. A tunnel takes the water to the reservoir, from which four flumes cut into the solid rock conduct the water to the station, where there are four sets of turbine generators of 10,000 h. p. each.

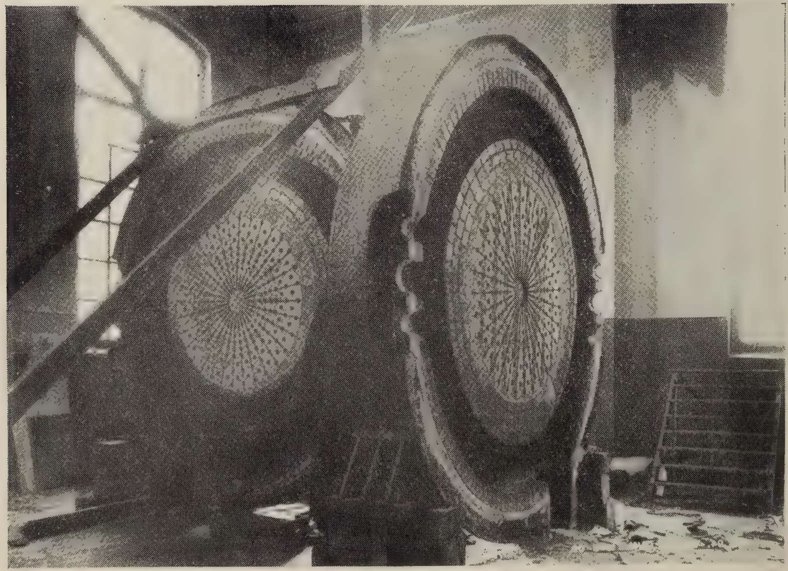


Arc Electric Connections

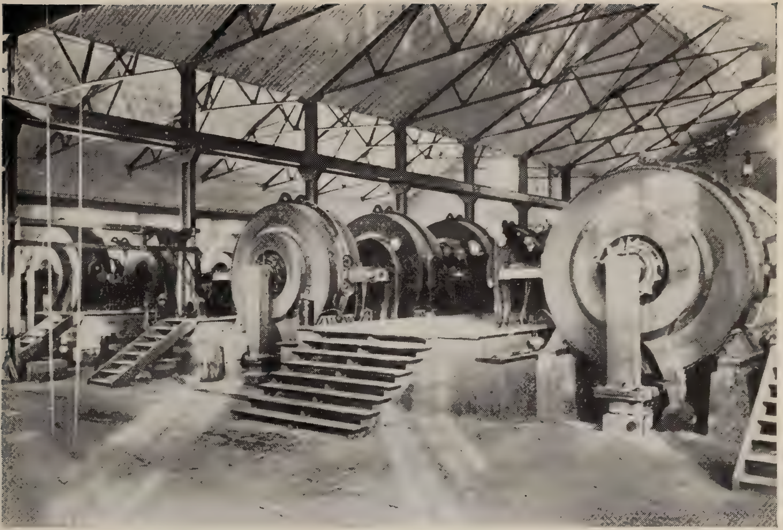


Birkeland-Eyde Furnace

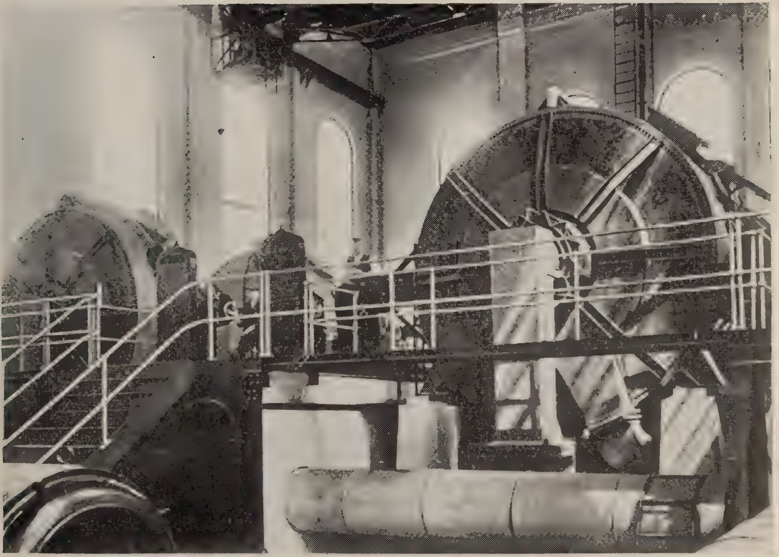
The Electric Arcs burning



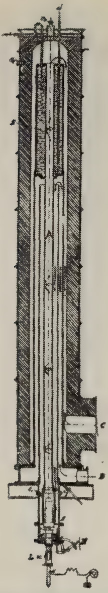
Interior of Electric Furnace



Furnace House at Notodden

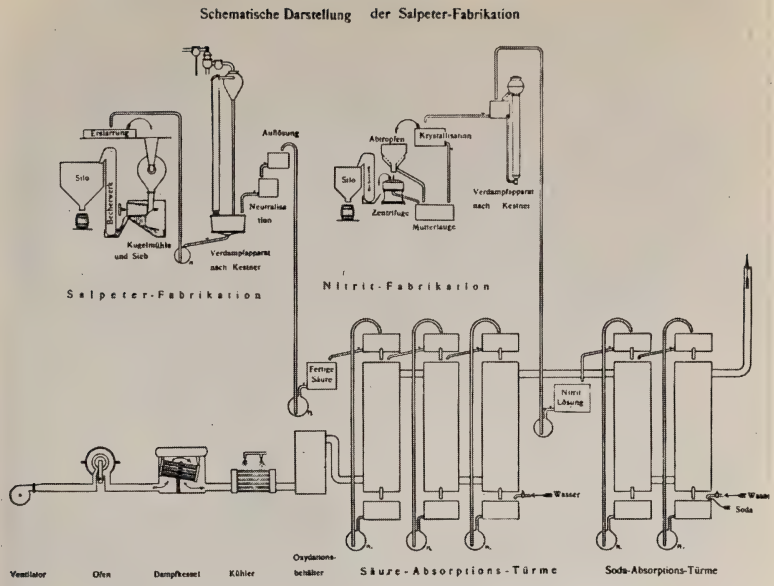


Birkeland-Eyde Furnace at Notodden, 3500 K.W.

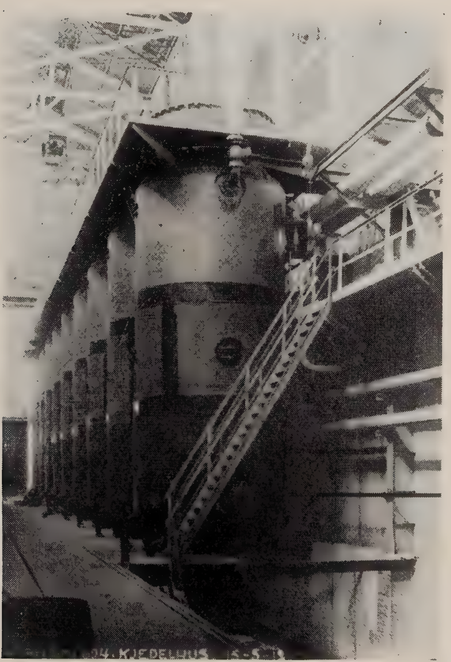


Schoenherr Furnace

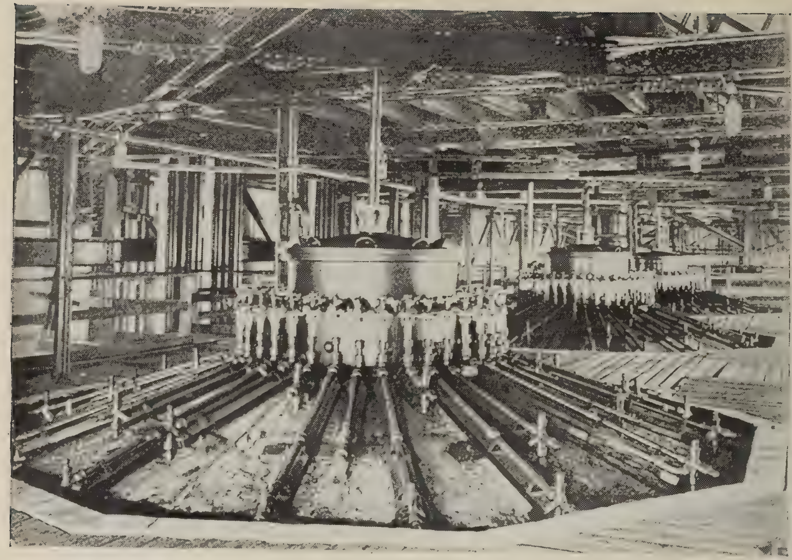
Schoenherr Furnaces (1,000 K.W.) and Birkeland-Eyde Furnaces (3,500 K.W.) at Rjukan



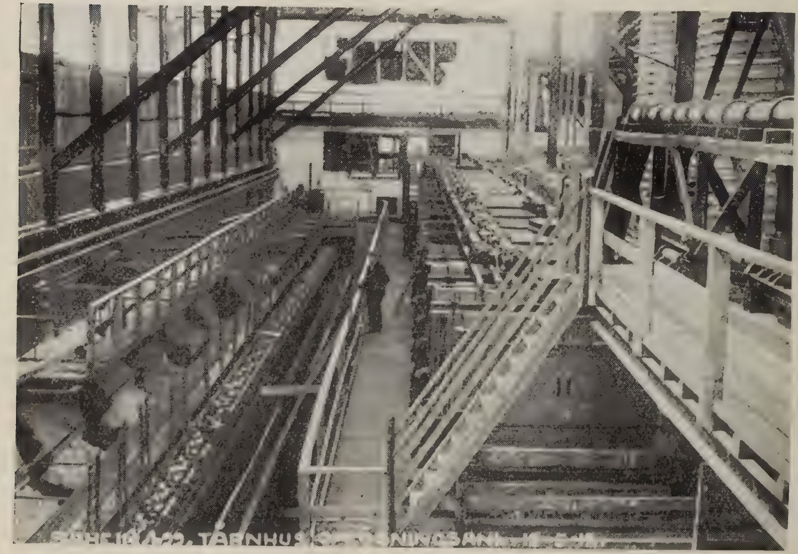
Schedule of Nitrate Manufacturing



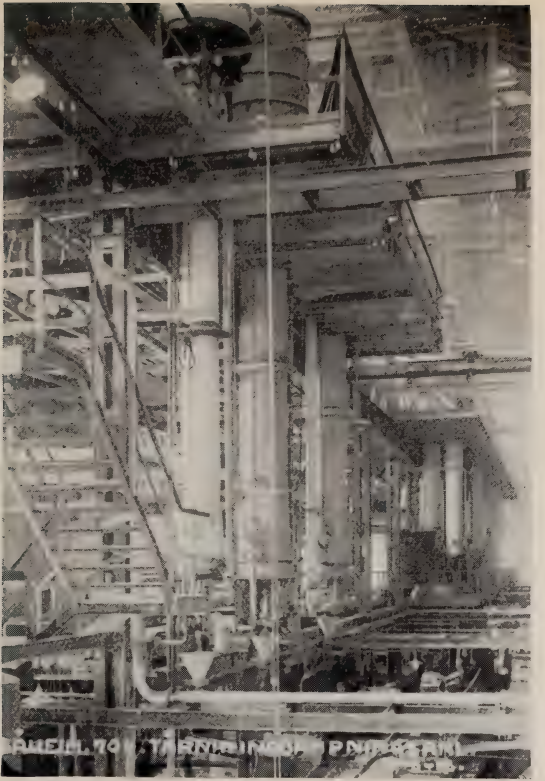
Boilers at Rjukan



Top of Granite Tower at Rjukan

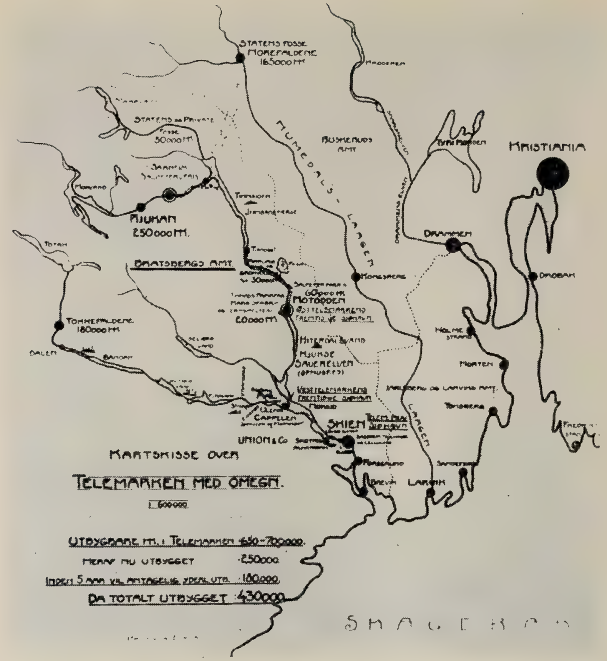


The "Dissolution" Vats



Evaporators

Nitrate of Lime Packed for Shipment



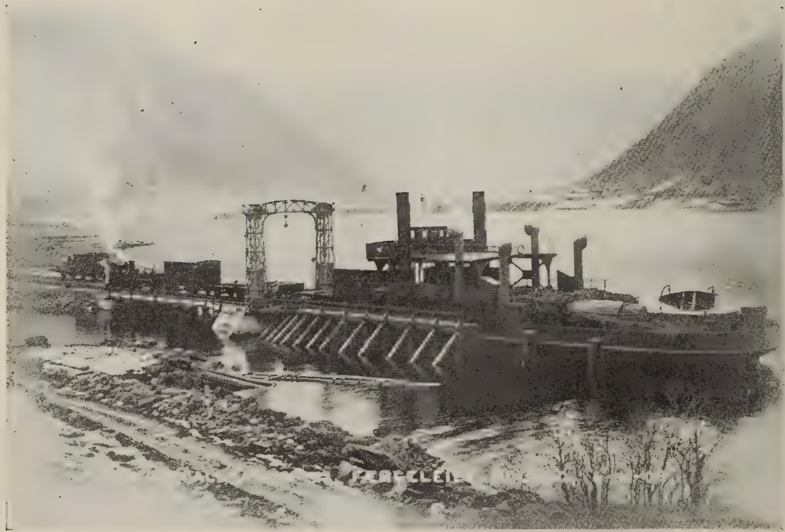
Map of Rivers Tinne and Maana, Showing the Location of Nitrate Factories

Notodden, 1903

Notodden, 1912

The Power Station at Lienfos Developing 20,000 H.P. and Furnishing Power to the Notodden Nitrate Factory

Svaelgpos Power Station, developing 40,000 H.P. This Station also Furnishes Power to the Notodden Factory



Ferry Boats on Lake Tinne, between Notodden and Rjukan

Transmission Lines from Power Station at Rjukan to Rjukan Nitrate Factory

The Power Station at Rjukan Developing 140,000 H.P.

The first Experimental Station for the Manufacture of Nitrates

Rjukan, 1907

Rjukan, 1912

Houses for Workingmen at Notodden

The generators are capable of producing 13,000 h. p. and rank among the largest units in the world.

The power of these two waterfalls is transmitted to Notodden by six separate transmission lines. Each line consists of six cables, 12 millimeters in diameter. The three phase alternating current of 50 periods is transmitted with a voltage of 10,000.

A second power station at Svaelgfos is now under construction. As the normal volume of water by an additional regulation of distant lakes in the same watershed will soon increase to 90,000,000 cbm., in the new power station, two units of each 10,000 h. p. will be built.

About 16 miles further up the river the first regulating dam at the Lake of Tinn was constructed at the same time as the water station of Svaelgfos and the factories at Notodden. The immense basin created by this dam makes it possible to store up fully 300,000,000 cubic meters of water.

For transportation purposes to and from the Rjukan factories it has been necessary to build two railways, one of 19 miles, from Notodden up to the lower end of the Lake of Tinn, and one of ten miles, from the lake up to the factories at Saaheim. Ferryboats and large barges provide transportation on the lake between the terminals of the railways.

The railroad from the lake up the narrow valley to Saaheim passes just beneath the large mountain Gausta; a few miles further up Saaheim and the factories are situated.

The transmission line is built on heavy iron masts. About two and one-half miles from the factory up in the valley lies the power station, a large building of granite, about 120 metres long. The Rjukan waterfall lies one mile further up in the valley. It is not only this waterfall itself, but the total fall in the river of a distance of about six miles which is to be harnessed up.

It is planned to have two power stations. The first, now in operation, lies at Vemork, on a ledge of the cliff, 1,000 feet below the terminal reservoir of the tunnel. The water is conducted from the reservoir down the mountain side to the turbines in ten huge flumes, side by side. These flumes are five feet in diameter. The upper sections are of riveted steel plates; the lower, where the pressure reaches 30 atmospheres, are made of welded plate, one inch in thickness. They rest upon a foundation built upon the solid granite of the mountain.

The water descends 971 feet to the Vemork turbines. Immediately upon leaving the power station the water enters another tunnel, excavated in the side of the cliff, and is conveyed to a point slightly more than three miles down the valley where a similar series of flumes for the second power house is now under construction. The total fall here is 909 feet.

When in full operation the two power stations will furnish the factories with 250,000 h. p. perhaps 270,000 h. p.

In the Vemork power house are ten units each of 14,000 h. p. Pelton wheels are used in the turbines on account of the great pressure of the water. They have a maximum capacity of 17,500 h. p.

A three-phase alternating current of 50 periods is transmitted from this power house to the nitrate works through 60 wires, partly of copper, but chiefly of aluminum. The working voltage is 10,000.

The reservoir on the top of the flumes is blasted out of solid rock from the intake, where a dam is built across the river.

For the regulation of the water supply a dam has been built at Lake Mösvand by means of which the level of the lake is raised over 46 feet. As the surface of the lake is not less than 23 square miles, nearly 900,000,000 cubic metres can be retained. The minimum flow in the river is in this way increased from 5 to 47 cubic metres per second, or the water power at Rjukan only from 30,000 to 250,000 h. p.

To give you an idea of the development of our industry I review the factories we have had at the different times:

Dates	Factories Utilized	No. H.P.	Employees	Workmen
July, 1903	Frognerkilens Febrik	25	2	2
Oct., 1903	Ankerlökken	150	4	10
Sept., 1904	Vasmoen and Arendal	1,000	6	20
May, 1905	Notodden	2,500	4	35
May, 1907	Notodden and Svaelgfos	42,500	12	403
Nov., 1911	Notodden, Svaelgfos, Lienfos and Rjukan I	200,000	143	1,340

A few years ago, at Saaheim as well as at Notodden, the population of the villages was limited to a small number of farmer earning with difficulty a bare living and without modern facilities.

We therefore were obliged to build up new towns in these deep, narrow valleys. But no money is spared to give our engineers and workmen comfortable lodgings. Careful provisions are made for street drainage, lighting, hospitals and other essentials for life in a town.

Before our industry was developed in Telemarken there were 500 people living in Notodden, against 5,000 in 1912, while Saaheim had only 50 inhabitants, whereas it now has between 5,000 and 6,000 citizens.

We have done our best to profit by experience and the methods of the Badische Company and the Farbenwerke-Elberfeld in taking care of our working forces, both as regards homes and otherwise. Of course, in Norway as well as everywhere in the world the question of labor is not easy to solve. Consequently we have tried almost from the very start to secure for ourselves a class of laborers that is reliable and permanent, so we provided for them, in the first place, homes, which are comfortable and suitable to their taste. They can rent the little houses at most reasonable rates and, if they so desire, they may after a while purchase their house.

In other respects we have also omitted nothing in reference to making the laborer feel glad that they have joined us in our efforts to raise the new industry of Norway to the highest possible standard.

From results of the use of our nitrate of lime, we find that it is the same as Chilian nitrate of soda and for certain soils it is even better. I have the pleasure of informing you that we are now sending many thousands of tons of Norwegian nitrate of lime to California and Hawaii for use in fruit orchards and sugar plantations; and the demand is twice as large as that of last year.

That our nitric acid and nitrate of ammonia are enjoying a good reputation is shown by the following extract from an English periodical, *The Sphere.* It was a peculiar coincidence that on my trip over here I happened to see this paper and the article in question. The article says in part: "Nitric acid is the main constituent of guncotton, dynamite and smokeless powders. One of the chemicals made at Notodden greatly reduces the heat of discharge, thereby prolonging the life of a big gun." And further: "Nitrate of ammonia obtained at Notodden by the marvellous electric process described here is the principal constituent of many of the explosives for mines and is, therefore, of high importance to the navy." I could not wish anything better to be said in favor of our products; you would believe I had put it into the newspaper myself (Laughter).

If you ask me what above all has contributed to such a rapid development of our industry, then I wish to mention the confidence the financial people gave me and the excellent collaboration between my engineers and myself. We are all working to create something great and useful for our country, and we all had in view the great importance this new industry would have from an international point of view.

There is, however, one thing which I wish to tell you and which more than anything else has contributed to the great success attained in the development of this industry, and that is that I mainly have employed young men for this work. (Applause.) This assertion may appear strange, but I assure you that it is the "lack" of experience which has created this industry. If I had paid attention to all the doubt and hesitation brought forward by the so-called authorities, during the development of our enterprise, the Norwegian people today would never have their nitrate industry. (Great applause.) Thanks to the young people, to their undaunted courage, energy and love of energy the work has been done, and it is in grateful remembrance of all our struggles, in joy and sorrow, that I look backward to the work that has been accomplished and the excellent results we have obtained. The Norwegian nitrate industry is not alone a technical but also a financial success.

For this success it is greatly indebted to the financial support given by the Swedish bankers Messrs. Wallenberg and the prominent French banks, the Banque de Paris et des Pays-Bas, Messrs, Rothschild and the Société Générale. Without the farsightedness and the liberality of these banking firms it would have been impossible for the young Norwegian industry to develop in such a short time to such a large extent.

And my own country, little Norway, which is the youngest daughter in the family of electrical industries, needs no more to be proud alone of the discovery of the South Pole, but is glad that it is possible for her to share in the solution of the most important questions relating to the world's household. (Prolonged applause.)

SYNTHETIC AMMONIA

H. A. BERNTHSEN

Mr. Chairman, Ladies and Gentlemen:

You all know that of the chemical elements that occur in large quantity on our planet nitrogen is one which is characterized by its complete indifference to chemical attack. Berzelius already says of it, that "it is difficult to recognise because it does not differ from other gases by any conspicuous property, but can only be recognised by means of properties which it does not possess." We see therefore both in science and in the arts that nitrogen is frequently used when it is desired to protect bodies from chemical attack by oxygen or when the commencement of an oxidation is to be prevented. The vacuum of the thermometers in instruments which are intended for high temperatures is, as you are aware, filled with nitrogen. The storage of readily combustible liquids, such as coal tar benzene and light petroleum naphtha, is effected by covering these bodies with nitrogen; their transport by applying compressed nitrogen. It is to the indifference of this element to chemical attack that the curious state of affairs must be attributed, that although we are dependent for all the conditions of life on compounds of this body and although we live in an infinite ocean of nitrogen, yet up to a short time ago we were not in a position to obtain nitrogen compounds from it. We were forced to cover our requirements of saltpeter for gunpowder, of nitric acid for gun-cotton and for nitration and many other applications, of ammonia for refrigerators, for instance, and so on, not by drawing upon the nitrogen of the air, but by utilizing ready formed nitrogen compounds, which ultimately result from the processes of plant life of earlier times. On the one hand Chili saltpeter and on the other hand the ammonia liquor obtained in small proportion as a by-product in the manufacture of gas or coke from coal served to supply the wants mentioned. We were also and in particular dependent on these two sources of nitrogen for the requirements of agriculture, which are far greater than all the others taken together.

But now, whilst the requirements of nitrogenous manures are constantly increasing in order to guarantee to the inhabitants of the world sufficient harvests, we have in all probability to reckon with a comparatively rapid diminution of the supply of natural Chili saltpeter. On the other hand, we cannot expect the balance to be maintained by a rapid increase in the production of ammonium sulfate, for this is dependent on the manufacture of gas and of coke, which increases but slowly. To this some working up of peat may be added, but a production of ammonia in this way as the main object of manufacture is impossible. The problem of the conquest of elementary nitrogen, of forcing this obstinate scamp into the service of our civilizatioon has consequently attained immediate importance for some time. Already three years ago at the Seventh International Congress of Applied Chemistry in London, I therefore had the honor of reporting on the utilization of atmospheric nitrogen and a new way for the production of nitrates from the air.

It might appear that the American continent, which is so richly blessed with the treasures of nature, can perhaps await with greater patience the development of events than could most European countries. For whilst the soil of the latter has been worked to the uttermost through centuries of agriculture, the unexampled development of this country has been caused, to a great extent, by the fact that agriculture had virgin soil at its disposal wherever it developed. There may still be places, such as the English poet Browning sings of:

"Nature frames
Some happy lands, that have luxurious names,
For loose fertility; a foot-fall there
Suffices to upturn to the warm air
Half-germinating spices; mere decay
Produces richer life; and day by day
New pollen on the lily petal grows,
And still more labyrinthine buds the rose."

In general however a change is occurring. The soil of the Eastern States, if it is for the future to yield full harvests, already requires the addition of manures, above all of the nitrogenous manures, for lack of the latter is most quickly noticed by the plants. A similar treatment would further be of great advantage in many parts of the Southern cotton States. Finally, in the course of years, the same requirements will be noticed in the West more and more, as the development of hitherto uncultivated land even there hardly comes any more into consideration. Nature will only continue to shower her favors on man if he adapts himself with reason to her immutable laws, as expressed by the poet:

> "Nur der verdient sich Freiheit wie das Leben,
> Der täglich sie erobern muss."

I therefore count upon your interest if I deal today in some detail with the nitrogen question, and announce to you some of the progress that has been made since the last Congress.

The three methods employed for the fixation of nitrogen are, first, the direct oxidation of nitrogen of the air forming nitric acid, nitrates, etc., secondly, the synthesis of ammonia from nitrogen and hydrogen, and thirdly, the fixation of nitrogen to metals or metalloids and, if desired, subsequently, decomposing the resulting products, nitrids, etc., producing ammonia. Three years ago it was the first of these ways that I principally dealt with. I was in a position to announce that in the processes of Birkeland of Christiania, on the one hand, and of Schönherr and the Badische Anilin- & Soda-Fabrik, on the other hand, two important ways had been opened up for oxidizing the atmospheric nitrogen with the aid of electricity obtained from water-power. Two companies had been formed by a Norwegian-French group, the Norsk Hydro Elektrisk Kvaelstofaktieselskab, and a German group Badische Anilin- & Soda-Fabrik together with the Farbenfabriken of Elberfeld and the Actiengesellschaft für Anilinfabrikation of Berlin. These undertakings and some other associated enterprises have in the meantime been developed with great energy and the factory at Saaheim, which converts about 120,000 h. p. of the Rjuakanfall into oxids of nitrogen, is now in full swing. The management of these works has passed into the hands of the Norwegian-French group by an arrangement with the German group.

The processes for the combination of nitrogen with metals, etc., producing metallic nitrids, cyanamids, and the like, and from these ammonia, have also progressed.

On the one hand the nitrolim obtained for instance by the union of nitrogen with calcium carbid, which is produced in several factories, is in part utilized directly as manure, in part a beginning has been made with the manufacture of ammonia from it by treatment with steam. On the other hand the nitrids, and especially those of aluminium and silicon, have been more closely studied. The process of Serpek for the production of aluminium nitrid has been developed by the Société Générale des Nitrures on a manufacturing scale in order to obtain on the one hand, pure alumina for the production of aluminium, and on the other, ammonia. Then again the Badische Anilin- & Soda-Fabrik in following up its work on barium cyanid from nitrogen, barytes and carbon took up the study of the production of titanium-nitrogen compounds and that of silicon nitrid from silica, nitrogen and carbon, and then in connection with this the production of mixed nitrids of silicon and aluminium, and of aluminium nitrid itself. In this field of work also an arrangement has been made between the firms working it, the Badische Anilin- & Soda-Fabrik having assigned their patents to the Société Générale, retaining for themselves certain rights of preparing the nitrids in question according to the patents of both companies. It is to be expected that this branch of industry will also develop satisfactorily.

I refrain from discussing any of these methods of fixing nitrogen and refer to the communications made by the inventors themselves and in particular to the lecture delivered by Dr. Eyde, the general director of the Norwegian companies referred to, a few days ago at this Congress.

I propose however today to deal, from my own direct experience, with the development of the *problem for the synthetical manufacture of ammonia from its elements.* A few years ago the solution of this problem appeared to be absolutely impossible. It has recently been the object of very painstaking investigations by Professor Haber and the chemists of the Badische Anilin- & Soda-Fabrik, and numerous patents have been taken out with reference to the manufacture. Apart from what is already published in this way, however, we have refrained from any other announcements until we were in a position to report something final with reference to the solution of the technical question.

This moment has now arrived and I am in the agreeable posiof being able to inform you that the said problem has now been solved fully on a manufacturing scale, and that the walls of our first factory for synthetic ammonia are already rising above the ground at Oppau, near Ludwigshafen-on-Rhine.

Permit me therefore to explain to you the fundamental points upon which this latest achievement of chemical industry is based.

The affinity of nitrogen for hydrogen, as is well-known, is so small that the two do not appreciably unite with one another either at ordinary or at a raised temperature. It has long been known that by electric sparks or by a silent discharge very minute quantities of ammonia can be formed from nitrogen and hydrogen. Also by conducting a mixture of hydrogen with nitrogen prepared in a particular way over spongy platinum, Johnson (1881), thought that he had obtained ammonia, in a quantity amounting to 0.0059 gram of NH_3 per hour. The nitrogen had been obtained from ammonium nitrite and passed through ferrous sulfate solution in order to remove nitric oxids. But nitrogen prepared in other ways did not yield the ammonia, so that Johnson assumed that there were two modifications of nitrogen. Wright (1881) proved that ferrous sulfate did not absorb all the nitrogen oxids and that the ammonia was produced by the action of hydrogen on nitrogen oxid in the presence of platinum. When using pure nitrogen he also obtained no ammonia. Baker (1883) also came to the conclusion that Johnson's statements as to the production of ammonia from its elements were mistaken. In no case could Baker notice any signs of the formation of ammonia, and he decided that hydrogen does not combine with nitrogen under the influence of heated platinum sponge.

Ramsay and Young on the other hand (1884) determined the decomposition of ammonia by heat at various temperatures. In this research, amongst other experiments, a mixture of dry nitrogen and hydrogen was passed through a red-hot glass tube filled with iron filings, or through an iron tube. The presence of ammonia could again not be proved. When using moist gases they noticed the presence of traces of ammonia, the formation of which they explained by the decomposition of water and the production of nascent hydrogen.

Again Perman, twenty years later, occupied himself with the question of the formation of ammonia from its elements. Upon slowly passing a mixture of nitrogen and hydrogen (1 vol. 3) through a glass tube heated to red heat, he obtained no ammonia, and the same result was attained when the tube was filled with porcelain. But when the mixture, in a moist condition was passed over red-hot iron or several other metals, or over asbestos pumice, pipe-clay, etc.,[1] traces of ammonia were formed, according to Perman's statement.

The investigations entered upon a new phase when Haber, armed with the weapons of modern physical-chemical methods, attacked the problem of the estimation of the ammonia equilibrium in 1904 in conjunction with van Oordt.[2] These investigators showed that at a temperature of about 1,000° C. decomposition of ammonia into its elements was almost, but not quite, quantitative (of 1,000 molecules of ammonia 999.76 were decomposed at a temperature of 1,020′ C.), and that consequently from these elements and under the same conditions very small quantities of ammonia were formed. Th authors used as contact material iron prepared from iron oxalate by heating to red heat in a current of hydrogen, and the iron was spread out upon purified asbestos. Further for some experiments nickel was precipitated from nickel nitrate upon pure silica. From a mixture of nitrogen and hydrogen corresponding to 100 parts of ammonia they obtained at the temperature mentioned about 0.02 parts of ammonia, and even this figure was subsequently, by more accurate examination (see below) shown to be still too high.

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[1] The action of these latter bodies was explained by the presence of iron in them, but it may be stated that the alleged action of asbestos, pipeclay and pumice is due to a mistake.

[2] Zeit, anorg. Ch. 43, 111.

In a further publication in 1905[1] these results were confirmed and summarised in the following sense, namely, at the temperature of commencing red heat and upwards no catalyser is capable lf producing more than traces of ammonia. The work was carried out at ordinary atmospheric pressure "for practical reasons," and it was pointed out that even under considerably increased pressure the position of the equilibrium would remain very unfavorable. Manganese was also taken into consideration as a catalyser, but its effect, as also that of nickel, was less satisfactory than that of iron.

While Haber in company with Le Rossignol[2] pursued this line of research, Nernst communicated the results of similar investigations to the general meeting of the German Bunsen Gesellschaft at Hamburg in 1907.[3] He was induced to take the matter up by the fact that Haber's figures showed a remarkable discrepancy from the equilibrium figures calculated according to the famous "heat theorem" of Nernst himself. In order to determine the otherwise so minute quantities of ammonia Nernst worked under pressure, using as a rule about 50 and up to 75 atmospheres, for according to the well known laws the concentration of the ammonia increases with the pressure. These results were published more in detail a year later by his co-worker Jost.[4] The latter used as catalysts besides platinum foil or iron (prepared from iron oxid in a current of hydrogen) also manganese (obtained from an electrically prepared amalgam by driving off the mercury in a current of ammonia). The figures here obtained for the equilibrium were still lower than Haber's, a fact which Nernst said was very regrettable, for otherwise one might really have thought of preparing ammonia synthetically from hydrogen and nitrogen. Haber and Le Rossignol made a further publication in 1908,[5] having now made their measurements also at a pressure of 30 atmospheres. By this means, it is true, the differences as against Nernst's experiments on account of the

[1] Zeit. anorg. Ch. 44, 341.

[2] Ber. 40 (1907), II, 2144.

[3] Zeit für Elekrochemie 13 (1907), page 521.

[4] Zeit. anorg. Chem. 57, 414.

[5] Zeit für Elektrochemie 14. (1908), page 181.

position of equilibrium, as also the maximum percentage of ammonia obtainable at a given temperature, were not quite got over, but at all events the figures of both scientists agreed in showing that this maximum *is extremely low.* At a temperature of 1,000° C. the volume percentage of ammonia calculated for atmospheric pressure is 0.0048% according to Haber and 0.0032% according to Jost, the corresponding figures at 700° C. being 0.0021% and 0.0174%.[1] That is, at these temperatures the ammonia equilibrium is extremely unfavorable, whilst at lower temperatures the catalytic action of the metals in question was too low to be able to work with them.

To sum up all these investigations on the direct combination of nitrogen and ammonia, it can be said that the problem seemed now to have become more than ever a mere dream, of which the realisation appeared to be quite beyond the bounds of possibility, so that there was every reason why the scientist should turn his back on so unfruitful a field.

In spite of this, Haber had a feeling that a technical synthesis of ammonia from its elements could be rendered possible, and placed himself in communication with the Badische Anilin- & Soda-Fabrik for the promotion of the work. He then showed, still in 1908,[2] that the technical preparation of ammonia from its elements can in fact be carried out, in spite of the unfavorable equilibrium and the low catalytic capacity of the contact metals used, if the mixture of nitrogen and hydrogen is kept under constant pressure during the whole of the operation and is subjected alternately to the catalytic formation of ammonia at a high temperature and then freed from ammonia by absorption or condensation at a lower temperature. Care must at the same time be taken that the heat of the reaction gases containing ammonia is transferred afresh to the gas mixture about to be acted on. In other words, the nitrogen-hydrogen mixture circulates, under continuous pressure, through the vessel for the formation of the ammonia, the vessel for the separation of the ammonia and a circulating pump, all these being connected up to a closed endless circuit. Of course it is advisable at the same time to replace with a fresh nitrogen-hydrogen mixture so much of the gas as is converted into ammonia.

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[1] Zeit. anorg. Chem. 57, page 429; Zeit für Elektrochemie 14, page 193.

[2] German Patent No. 235421, Oktober 13, 1908.

It was further found when working according to this continuous process of Haber's under conditions which induce a relatively high concentration of ammonia that the advantages of the heat regeneration are no longer of such vital importance, but that it is sufficient in this case to work continuously under pressure without at the same time regenerating heat.[1] Finally it was seen[2] that it is not even absolutely necessary to work *continuously* under pressure (that is, to circulate the gases continuously under pressure), if the reaction is carried out under very high pressure, for instance at about one hundred atmospheres, preferably however at from 150 to 250 atmospheres and even higher. A range of pressure is hereby introduced which had never been touched in the synthesis of ammonia and was also something quite new in any manufacture, for no one had previously so much as thought of carrying out technically a catalytic reaction with gas currents at the necessary high temperatures under such an enormous pressure.

By these means, under a pressure of 200 atmospheres, at a temperature of from 650–700° C. and using an iron catalyst prepared from the purest iron oxid, occupying a space of 20 ccm, and with a gas speed of 250 liters per hour (measured at ordinary pressure) it is an easy matter to obtain for example 5 grams, or per liter of contact space 250 grams, of ammonia in an hour.

The following further point comes here into consideration. All previous publications had in view exclusively the determination of the ammonia *equilibrium*, which can be found theoretically most accurately in a steady volume of gas. If a current of gas is used, the rate of flow must naturally be kept low, so that one may be sure that equilibrium is reached. Now there were no indications as to how far the concentration of the gas would be reduced when the rate of flow is raised, and whether the concentration would be sufficient when such a rate of flow is taken as must be done when working on a technical scale. Haber has therefore rendered signal service in showing that one can work successfully with such higher rates of flow.

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[1] French Patent No. 406943.

[2] German Patent No. 238450, September 14, 1909.

A diagrammatic exposition of an apparatus used by Haber is shown on the chart[1] before you. The catalyst is in a metal tube which opens in front into a heat regenerator. The gas mixture passes from behind into the metal tube, through the catalyst and then through the heat regenerator into a circulating pump. Leaving this it passes in countercurrent round the outside of the regenerator tubes and the tube containing the catalyst and then enters this in front, repeating this journey again as described. The apparatus can be protected against loss of heat to the air by packing it in isolating material and can be enclosed in an outer shell which can withstand the pressure. The whole of the circulation takes place at high pressure. The catalyst is kept at the suitable temperature by electrically heating from within or by applying heat from the outside. Between the heat regenerator and the circulating pump the gases pass through either an absorber or a condenser for ammonia. By means of a branch tube the nitrogen and hydrogen combined to ammonia can be replaced.

Finally, it was a great step forward when Haber found catalysts with the property of rapidly combining nitrogen and hydrogen to ammonia in sufficient quantity even at much lower temperatures than those previously required. He found this to be especially the case with osmium. This metal has such a very favorable action already at 550° C. and below, that under a pressure of 175 atmospheres a gas concentration of 8 volumes per cent of ammonia can be obtained. This was all the more astonishing, as platinum, which is closely related to osmium, has but a very slight catalytic action. For use on a large scale, however, osmium scarcely comes into consideration, for the world's stocks according to Haber do not amount to much over 100 kg and only small quantities are won annually; this quite apart from its high price and very unpleasant properties.

Very soon Haber found in *uranium* a further very good catalyst; it can be employed in the form of the metal, of an alloy, or nitrid, or carbid. In the form containing carbon or carbid, such as is produced in the electric arc from uranium oxid and carbon, it crumbles in the gas mixture under high pressure to a very fine powder containing nitrogen, which even under 500° C. has an excellent catalytic action. No water, however, or impurities which give rise to water must be present in the gases, when uranium is used in this way. From the following table which shows the equilibria obtainable at different temperatures and pressures, can be seen the importance of the temperature at which a catalyst is active for the equilibrium of the ammonia produced.

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[1] See the sketches in Haber's article in the Zeit. f. Elektrochemie, 16 (1910) pp. 244–5, and also British Patent No. 17951/09.

Equilibria (N_2:$3H_2$)

Temp.	Pressure	
	1 atm.	100 atm.
800°	0.011%	1.1%
700°	0.021%	2.1%
600°	0.048%	4.5%
500°	0.13 %	10.8%
400°	0.48 %	

Haber published a short report of his work in 1910.[1] To my great regret Professor Haber has not been able to accept the invitation of the officers of this Congress to report personally here on his researches, owing to being hindered by pressure of work. I have great pleasure in fulfilling his wish and thanking the officers of the Congress today for the honorable invitation, and express his regret to this meeting that he is unable to be present.

I now turn to the work of the Badische Anilin- & Soda-Fabrik on the technical development of the process. This work was of course at once taken up in 1908 after the first communications of Professor Haber, and Dr. Carl Bosch was entrusted with it. In conjunction with his colleagues and with equal energy and experience in the field of chemistry and engineering he has successfully carried out the practical application of the process.

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[1] Zeitschr. f. Elektrochemie 16, 244/5.

The problems to be solved were quite new and strange and demanded the mastery of very unusual difficulties. Although working with compressed gases under pressure at very low temperatures was already known in the industry, the problem here was the totally different one of constructing apparatus which should be large enough and at the same time able to withstand the high pressure with temperatures not far from a red heat. How well founded were the doubts as to the possibility of a solution of this task can be gathered from the instance of the wrought iron autoclaves commonly used in the color industry. Here, in spite of a very low range of temperature of at most about 280° C., only pressures of from 50 to 100 atmospheres at the utmost come into consideration. But above 400° C. iron loses its solidity to a very extraordinary degree.

There is further the circumstance that the metals which come into consideration for the construction of the apparatus, and especially iron, are chemically attacked above certain temperatures by the gas mixture under pressure. Although the formation of iron nitrid from iron and ammonia, which could have been expected according to the work of Fremy and others, can be avoided, yet it is found, for example, that steel containing carbon loses its carbon at the temperatures in question owing to the action of the hydrogen, so that its capability of withstanding pressure is reduced to a minimum. It was further found, when using iron itself, that it is completely changed in its qualities, chiefly by taking up hydrogen. Again, at such high temperatures iron is pervious to quite a remarkable degree to hydrogen under high pressures. The question of materials for the apparatus therefore raised at once considerable difficulties, but at length these were more than overcome by suitable construction, details of which, I am sure, you will not expect from me today. The danger of serious explosions or of great sudden flames of hydrogen, if the apparatus happens to become defective, can be guarded against by setting it up in bomb-proof chambers.

Great care must naturally be taken that oxygen or air does not get into the apparatus or the piping, for at the high pressure obtaining the explosion range is reached with merely a slight percentage of oxygen. Special devices are used to watch over this content of oxygen, and immediately a definite percentage is touched the alarm is automatically raised. Besides this the proper constitution of the gas mixture in circulation is controlled by analysis from time to time.

The *ammonia* can be *removed* either by being drawn directly from the apparatus in liquid form, or an absorption agent can be suitably introduced into the apparatus. The simplest absorbent, water, has been found to be suited for this purpose; under the pressure used a concentrated solution of ammonia is secured. Any ammonia that may remain in the gas after the bulk has been removed by one or other of these methods can be further removed by special chemical means, if it is not preferred simply to leave it in the circulating gases.

As before mentioned, Haber observed that there are contact agents which are much more active than those previously known (osmium and uranium being indeed found to be much more active than pure iron prepared from oxalate of iron or oxid of iron, platinum, pure manganese, chromium, and nickel, already at considerably lower temperatures). The Badische Anilin- & Soda-Fabrik therefore decided to *study the various catalysts* very minutely.

In the course of these investigations, the new fact discovered, that ammonia catalysts in general are made more active by the presence of certain foreign bodies, has proved to be of prime importance. Amongst these "promoters," as they have been termed, are oxids, hydroxids, or salts of the alkalies, of the alkaline earths and the earth metals, further many other substances of the most varied nature, especially other metal compounds or metals themselves. In many cases just a minute quantity suffices to raise the catalytic activity. This trait is common to all catalysts, for there is not one but its activity can be raised by these means. Care must however be taken (for reasons to be discussed later on) not to choose such mixtures that metalloids such as sulfur, selenium, tellurium, phosphorus, arsenic, boron, etc., under the conditions prevailing, are incorporated in the catalyst. Similarly compounds of metals with a low melting point which are readily reduced by hydrogen and which themselves do not act as catalysts must be avoided; such metals themselves as lead, tin, zinc and bismuth must also not be added.

The promoters mentioned can be added either to the prepared catalyst or to the substances used in its preparation, or the catalyst can be prepared from such materials as already contain such conditions in suitable mixture (for example magnetic ironstone). Under certain circumstances the action of these foreign bodies is specially powerful, viz. if the metals, or oxids, or carbonates, or other compounds which are converted into oxids on heating, are first heated to high temperatures, preferably to melting point, and so that the resulting product consists chiefly of oxids. When proceeding in this way with metals, for instance iron, of course sufficient oxygen or oxygen-producing compounds must have access. The mass of oxids obtained as described is suitably broken up and filled into the contact stove either directly or after reduction. In this case extremely small quantities of foreign substances suffice to secure a high and continuous activity of the contact mass.

We consider the marked activity of catalysts prepared in this way to be in the first place due to the fact that the additions mentioned dissolve, on heating, in the highly heated metallic oxid or become finely divided in it, and that in this way during the following reduction a sort of skeleton, which however is hardly to be detected, is formed inside the metallic mass. This effectually prevents a diminution of the surface and therefore also of the catalytic properties of the mass.

It was then further found that good results can also be achieved with pure iron, that is to say, that we can work with it at temperatures of for example not much above 600° C., thus if the iron intended for the catalysis is prepared from the oxid or other iron compound at a comparatively low temperature, preferably not above 600° C. It can also be prepared by highly heating pure iron oxids, or pure iron in the presence of oxygen, preferably to melting point, and by reducing the mass of oxid preferably at a not too high temperature.

Also manganese, which is related to iron, gives under a specific condition good results, without the addition of foreign substances.

This condition is that care be taken to free completely the mixture of nitrogen and hydrogen, before it enters the contact space, from oxygen, either free or combined, for instance as steam or water. Merely drying with calcium chlorid is not sufficient. In the case of several other catalysts too a similar careful drying has proved to be useful.

Again, it has been found that another member of the iron group, molybdenum, is by itself an excellent catalyst. Compounds of molybdenum can also be used, for instance molybdic acid or ammonium molybdate.

Under certain conditions, not published as yet, tungsten, either the metal itself or as an alloy or a nitrogen compound, has been found to be a suitable catalyst.[1]

In view of the shortness of the time I must refrain from a more exhaustive discussion of this most interesting chapter of the contact bodies. It will be quite evident from what I have said that the industry has now a number of active contact bodies for the synthesis of ammonia at its disposal, and can select from case to case the most suitable.

Another discovery of first-class importance for the industrial application of the catalysis of ammonia was the recognition of the fact that there are special poisons, so to speak, for the reaction. That is to say, there are substances which hinder or prevent the reaction, although the contact mass does not suffer a noticeable chemical change, envelopment, or destruction. In the literature there was no indication whether there were poisons at all for the contact mass in the catalytic manufacture of ammonia, or what their nature would be. In actual manufacture such contact poisons were known only in the case of the catalysis of sulfuric anhydrid and even here only when platinum was used. When employing other contact bodies, such as iron oxid, or burnt pyrites, there was nothing known of contact poisons; on the contrary, it has even been shown that the presence of arsenic, which is a poison for platinum, has actually a favorable action when iron oxid is used as catalyst.

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[1] Such conditions are e. g. that tungsten, or its compounds mentioned, is prepared at temperatures not much above 600° C, that they are prepared from tungsten compounds by means of ammonia, in which case there is no restriction to a temperature of about 600° C.

It has now been ascertained that some of the poisons in the synthesis of ammonia of quite a different nature from those of the sulfuric acid process, they are for instance, sulfur, selenium, tellurium, phosphorus, arsenic, boron, or the compounds of these elements such as sulphuretted hydrogen, arsenic hydrid, phosphorus hydrid, as also many carbon compounds and certain metals of low melting point which can readily be reduced by hydrogen from their compounds, for example lead, bismuth and tin, which do not act catalytically. Oxygen-sulfur compounds, such as SO_2, which acts directly and smoothly in the sulfuric acid catalysis, are very poisonous. Extremely minute quantities of these bodies, which are almost always present even in the purest commercial products or in the so-called pure gases, suffice to render the catalysts absolutely inactive or at least to diminish their action very seriously. Thus iron, for example, prepared from ordinary iron oxid with a content of one per thousand of sodium sulfate is, as a rule, inactive. Iron containing one-tenth per cent. of sulfur is generally quite useless, and even with one hundreth per cent. is of very little use, although in appearance and when examined with the ordinary physical and chemical methods no difference at all can be detected as compared with pure iron.

The recognition of these facts gave rise to two problems:

(a) the preparation of contact masses free from poison or the removal of such poisons from them, and

(b) freeing the gases to be acted on catalytically, from all contact poisons.

In order to free the contact bodies from these harmful substances, the ordinary methods for removing them can of course be applied. The contact action can also be improved by heating contact metals which are inactive or of little use owing to the presence of contact poisons, in the presence of oxygen or of bodies yielding oxygen. Or the metals can be heated, for instance, in the presence of oxygen with the addition of suitable compounds such as bases, and the resulting products reduced. These operations can be repeated if necessary. If more of such a body as mentioned is added than is necessary, it may act not merely by removing the poisons, but promote the yield, as I have already described to you.

On the other hand it is necessary, as I remarked, to take the greatest care that nitrogen and hydrogen are free or freed completely from all contact poisons. Thus a trace of sulfur, one part per million, in the gas mixture can under certain conditions be injurious, so that even electrolytically prepared hydrogen must generally be further specially purified. The minute purification of the gases is even more important when hydrogen prepared, for example, from water gas is used. The impurities too taken up from iron piping play sometimes an important part, and impurities which get into the gases during the compression, such as machine oil, often have a harmful effect.

The best method of removing impurities from the gas mixture depends in turn on the nature of these purities and consists, for instance, according to the case, in filtering, washing, conducting over solid absorption agents and so on. One good method is to bring the gases into contact with the material of which the contact mass is prepared at a raised temperature, before passing them over the actual catalyst. The material takes up the impurities, and must of course be renewed from time to time. The negative results of earlier investigators in the formation of ammonia when using base contact metals (Wright, Ramsay and Young, and, more recently again, 1911, Neogi and Adhicàry), according to which nitrogen and hydrogen do not combine in the presence of iron, are in my opinion probably due, for the most part at least, to the use of metals or gases not free from contact poison. That previous inquirers had not the remotest idea that sulfur in the contact metal could be injurious, is evident from the fact that they passed the gases without hesitation through concentrated sulfuric acid in order to dry them. The sulfuric acid thus taken up and the sulfur dioxid often contained in it can poison even the best catalyst very speedily and render it unfit for use. Or the contact metals were sometimes prepared directly from the sulfates, although a metal sufficiently free from sulfur can scarcely be obtained by this method.

A painstaking study, for which we are indebted principally to

Dr. A. Mittasch and which involved literally many thousands of experiments, has afforded an insight into the importance of substances of the most varied nature as promoters and poisons and thus a sure foundation has been prepared for a reliable continuous manufacture with a good yield of ammonia.

(The production of ammonia was now demonstrated.)

The question has not yet been touched upon in the foregoing, how the elements nitrogen and hydrogen which are requisite for the new ammonia process can best be produced on a technical scale. Theoretically, the task would be unusually simple. If you remember that the terrestrial atmosphere according to the studies of A. Wegener and others consists of practically pure hydrogen at a height of about 120 kilometers, indeed at a height of about 70 kilometers consists of almost exactly one volume of nitrogen and three volumes of hydrogen besides a trace (about one-half per cent.) of oxygen, you will understand that all the conditions were given for an ammonia factory according to Jules Verne. For it would then merely be necessary to suck down the gases from the higher strata of the atmosphere by a sufficiently long pipe line.

For us, poor mortals, matters are not so ideally simple, for, as the poet says,

> "hart im Raume stossen sich die Sachen."

Fortunately, however, there is no great difficulty in separating nitrogen from the air, either by physical means, according to Linde's process, or chemically, by removing the oxygen with glowing copper, burning hydrogen, or the like. And for the preparation of hydrogen in recent times a great deal of useful work has been done too, owing to the extensive growth of its field of application. In certain works it is at disposal in large quantities as a by-product of the electrolysis of common salt. Besides this it can be produced, for example, by passing steam over red-hot iron, or from water-gas, for instance, by separating its constituents hydrogen and carbon monoxid by cooling to a very low temperature. All the methods of preparation which come into consideration we have of course minutely examined; owing to the comparatively trifling differences in the cost of production various methods can be employed. At all events, both elements, nitrogen and hydrogen, are at the disposal of the new industry to any extent and sufficiently cheap.

As the production of these elements is not confined to the presence of cheap water power, all those countries where the manufacture of calcium nitrate, owing to the want of such power, is not practicable, as for instance in Germany, are now in a position to profit by the new industry. As I remarked at the outset, there is every reason to assume that this industry will find a fruitful field of employment in America, where the demand for nitrogen-manures will soon be greater than hitherto.

It can also be regarded as certain that the development of this new industry will not take place at the cost of other branches of industry and commerce. Bear in mind for a moment the present annual requirements for nitrogen-manures and their continued growth. According to the table before you (see appendix) these figures reached the remarkable total of 467.2+326 *i. e.*, 793.2 million marks (about 190 million dollars) in 1911, and each year sees an increase. In the last few years the increased demand for ammonium sulfate amounted to about 10%. The increase of production from 1910 to 1911 amounted to 69,000 tons, and from 1908 to 1911 on the average as much as 110,000 tons, or 110 million kilograms valued at about 30.6 million marks (7.3 million dollars). Similarly the nitrogen requirements of the world for manure purposes in the form of saltpeter is growing. Chili exported in 1908 about 2,052,400 tons of saltpeter, and already in 1911 the figure was about 2,449,400 tons, that is an annual increase of nearly 150,000 tons valued at approximately 29 million marks (7 mill. dollars). Indeed the European deliveries, according to the latest reports, from January to the end of June 1912 reached as much as 1,449,000 tons, a demand which Chili was hardly able to meet.[1] The average annual increase from 1901 to 1911 amounted to 99,500 tons. That is to say, taking saltpeter and ammonium sulfate together and reckoning only the average increases, calculated on nitrogen, we have an annual increase in production of about 38,000 tons nitrogen, corresponding to nearly 185,000 tons of ammonium sulfate.

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[1] During the first six months of 1912 the production in Chili was roughly 10,000 tons less than in the corresponding period of 1911, and at the same time stocks in sight in that country receded by round 50,000 tons.

It can thus be seen what enormous quantities of synthetic ammonium sulfate must be produced to affect the total production by as much as one year. The saying so often applicable, that

"Das Bessere ist der Feind des Guten,'

will thus probably have no meaning in this field. A peaceful development of the various new industries for the combination of the nitrogen of the air side by side is to be expected, and without encroaching at all on the previous production of nitrogenous manures, a favorable horoscope may be cast for a fortunate career for the new industry.

CHILI SALTPETER

Year	Chilan Export[1]	Price[2] per ton	Total value	Increase
1900	1,454,000	162.2	216.6	1901–11 995,400 tons, that is, an annual average of 99,500 tons containing 15.5%, *i.e.*, about 15,400 tons nitrogen, valued at 19 million marks.
1901	1,274,000	172.8		
1902	1,379,200	176.2		
1903	1,457,600	178.4		
1904	1,497,100	196.6		
1905	1,652,200	204.8	338.2	
1906	1,731,800	215.0		First six months 1912 150,000 tons valued at about 29 million marks as against corresp. period 1911.
1907	1,653,600	214.4		
1908	2,052,400	193.3		
1909	2,133,900	184.5	393.7	
1910	2,334,000	177.6		
Jan.–June 1911	(1,299,000[3])			———
1911	2,449,000	190.7	467.2	[1]According to the figures of the Association Salitrera.
Jan.–June 1912	(1,449,000[3])			[2]Annual average Hamburg quotations. [3]Semi-annual deliveries in Europe.

AMMONIUM SULFATE

Year	World production	Price per ton	Total value	Increase
1902	543,000	241[1]	131	1908–1911 329,000 tons, *i. e.*, an annual average of 110,000 tons, containing 20.5%, *i. e.*, about 22,500 tons nitrogen, valued at about 30.6 million marks.
1908	852,000	237	202	
1909	978,000	230	225	
1910	1,111,800	248.5	276	
1911	1,181,000	about 278	328	——— 1)Quotations fob. Hull.

THE GRAND BANQUET

This took place on the evening of Thursday, September 12, in the Grand Banquet Hall of the Hotel Waldorf-Astoria, the President of the Congress, Dr. William H. Nichols, presiding as toastmaster.

The Honorable William J. Gaynor, mayor of the City of New York, addressed the diners on behalf of the City of New York and his well-chosen remarks were received with applause and appreciation.

Mrs. Leo H. Baekeland spoke on behalf of the ladies who had come to the Congress and for those who had also contributed much to the social features of the Congress by their arduous work on the various ladies' committees.

The toastmaster then called upon representatives of the various countries present who responded in happy vein. The responses for the different countries were made as follows:

Australia—Mr. William Percy Wilkinson.
Austria—Geheimrat Friedrich Strohmer.
Bohemia—Mr. E. Votocek.
Belgium—Mr. Paul Hagemans.
Canada—Dr. Anthony McGill.
Chile—Professor Belisario Diaz-Ossa.
China—Mr. Yung Kwai.
Colombia—Dr. Don Guillermo Wills.
Denmark—Dr. Einar Biilman.
France—Jean de Pulligny.
Professor Leon Lindet.
Germany—Geheimrat von Buchka.
Geheimrat Engler.
Great Britain and Ireland—Sir William Ramsay.
Professor Gilbert T. Morgan.
Italy—Professor Guiseppi Bruni.
Mexico—Professor Adolfo P. Castanares.
Norway—Dr. Sinding Larsen.
Dr. Samuel Eyde.
Persia—Mirza Ali Kuli Kahn.

Russia—Professor Paul I. Walden.
Sweden—Professor Knut W. Palmaer.
Switzerland—Professor F. P. Treadwell.
Union of South Africa—Dr. James Moir.

There was no response in behalf of Japan because of the recent death of the Emperor; out of respect to His Majesty's memory the entire assemblage rose and remained standing in silence for a period.

THE FINAL GENERAL MEETING

This was held in the Great Hall of the College of the City of New York. The meeting was called to order by President Nichols at 11.35 a. m., Friday, September 13, 1912.

The President: I think that the officers of the Congress and the committees which have had its work of preparation in charge may congratulate themselves somewhat at the end of their labors on the success of the arrangements which have been made, on the number of members to the Congress, and on the number of attendants at the various functions.

As there are many things to do today, and as it is not any too cool here, I shall be very very brief in everything that I say, and I do not want you to think that by that means I am in any way trying to elude any of my duties, but I am simply considering your comfort.

It has been customary in the preceding Congress to have a report from each of the Presidents of the twenty-four sections. We have avoided that today by having printed, and in the hand of every one, a complete report of all of the twenty-four sections, which will be more useful to you in hand than by simply carrying about in your memory, and probably save an hour of our time.

The net result of the work of this organization is 4,400 members, as you will note by this report (applause), of which 2,129 coming from twenty-seven different countries, attended the Congress meetings and registered. Of these 246 were ladies.

The rest of the report is very clear, and if you will take it with you, it will supplement the report usually made by the chairmen of the twenty-four sections. If that is agreeable, I will pass on to the next business.

I have in my hand a letter from the Imperial Russian Embassy, dated the fifth of September, and addressed to me as President of the Congress. The Imperial Ambassador has recently met with a death in his family, and has been unable to be present with us today to present this in person, and I am sure we all extend to him our sympathy in the affliction which is just now very prominent in his home.

The letter is as follows:

NEWPORT, the 5th of September, 1912.

"MR. W. H. NICHOLS,
PRESIDENT OF THE VIIITH NATIONAL CONGRESS OF APPLIED CHEMISTRY.

"Sir:

"I am instructed by my Government to inform you that for the following Ninth International Congress of Applied Chemistry, it has decided to propose to have it held in St. Petersburg in 1915. I have the honor to ask you to convey in your quality of President to the delegates of the different Governments now participating in the sessions of the Eighth International Congress of Applied Chemistry the invitation of the Imperial Russian Government to unite for its next Ninth meeting in 1915 in St. Petersburg.

"Hoping that I shall be able to send a favorable answer to my Government, I beg you, sir, to accept the assurances of my high consideration.

(Signed) "E. BAKHMETEFF,
"*Imperial Russian Ambassador.*"

THE PRESIDENT: This invitation will be supplemented by Dr. Kablukoff.

PROFESSOR I. KABLUKOFF:

Monsieur le Président, Mesdames et Messieurs:

En qualité de représentant de la plus ancienne Université de la Russie, de l'Université de Moscou, j'ai honneur de prier

le Congrès International de chimie appliquée d'accepter l'invitation du Gouvernement Russe.

Les Congrès Internationaux offrent une arène pour un libre échange de différentes opinions, mais cette différence d'opinions ne fait qu'unir cordialement les opposants et nous, les Russes, nous aspirons à ce que le Congrès suivant soit convoqué dans notre pays, parce que du choc des opinions jaillit la vérité, et la vérité est le but unique et convoité de la science qui réunit les nations.

Nous désirons que notre pays et notre peuple soient mieux connus par les étrangers et nous ne manquerons pas de faire tout notre possible pour vous rendre le séjour en Russie agréable.

Je ne veux pas abuser de votre indulgence et je me borne à proférer la parole de l'hospitalité russe: soyez les bienvenues, Mesdames et Messieurs.

THE PRESIDENT: I am going to ask Professor Lindet, President of the Second Congress, to make a motion.

PROFESSOR LINDET:

Monsieur le Président, Mesdames et Messieurs:

Le comité des anciens présidents a été unanime pour accepter l'invitation du Gouvernment russe et pour remercier Messieurs les délégués russes et les chimistes russes qui ont assisté à ces Congrès d'avoir bien voulu appuyer l'invitation faite par le Gouvernement russe et nous convier à de nouvelles assises dans trois ans, c'est-à-dire en 1915 à St. Pétersbourg.

THE PRESIDENT: I will ask Sir William Ramsay, President of the Seventh Congress, to second the motion.

SIR WILLIAM RAMSAY: I have much pleasure, as one of the former Presidents of this Congress, in seconding the motion which has been made by my colleague, M. Lindet. I am sure that the Russians will do all that they have promised to make this Congress a success, and I am quite confident that those members who may go there, will meet with a very hospitable reception, a reception such as those who have previously gone there, have met with.

(A rising vote was taken, and the President announced that

it was the unanimous pleasure of this Congress to accept the invitation to meet in Russia in 1915.)

THE PRESIDENT: A little later in the day, if it be not forgotten in the press of business, it is the intention of the International Commission to recommend to that Congress to consider and decide if the Tenth Congress shall be held in 1918 or 1920.

We are now ready to receive nominations for Honorary President and for President of the Congress. And I would nominate as the unanimous opinion and ticket of the International Commission, for Honorary President Professor Demetrius P. Konovaloff, Emeritus Professor of Chemistry at the University of St. Petersburg, and formerly director of the High School of Mines, at present Assistant Minister for Commerce and Industry. Professor Konovaloff is well known to the world of Chemistry by his researches in physical chemistry.

And for President, I nominate, with the concordance of my colleagues, Dr. Paul I. Walden, Professor of the Polytechnic High School of Riga, former Director of this school, member of the Academy of Sciences, St. Petersburg, Honorary Member of the Chemical Society of London, and an author of many hundreds of works on organic, physical and electro-chemistry.

Are you ready to have me put the motion for the election of these two gentlemen?

(A vote was taken by show of hands.)

It is a vote, unanimous, and I will ask Dr. Walden to announce whether he will accept or not.

PROFESSOR WALDEN:

Herr Praesident, meine Damen und Herren:

Die soeben auf mich gefallene Wahl ist eine Auszeichnung besonderer Art und auch eine Pruefung besonderer Art. Fuer den abwesenden Professor Konovaloff, der sicherlich bedauern wird, nicht hier gewesen zu sein und an unserem gemeinsamen Fest teilgenommen zu haben, kann ich nur im Voraus seinen Dank und sicherlich seine Zusage aussprechen. Fuer mich selbst aber sind die Gefuehle sehr gemischt. Ich muss sagen: Viele Ehre, viele Arbeit, viele Enttaeuschungen, viele graue Haare. Wenn ich und Professor Konovaloff diese Wahl anneh-

men, so sind wir dessen wohl bewusst, dass unsere Kraefte nicht heranreichen werden, diesen Pflichten gerecht zu werden, aber wir sehen darin eine Ehre, welche unserem grossen Vaterlande und den grossen Maennern—grossen Chemikern unseres Landes zu Teil geworden ist. Ich erinnere Sie nur an einige Namen, an einen Mann, den nur die wenigsten von Ihnen nicht kennen, Lomonossoff, welcher vor 160 Jahren bereits eine moderne Elektrochemie gegruendet hat; an Grotthus, einen russischen Chemiker vor 100 Jahren. Ich erinnere Sie an Hess, der auch Chemiker war, und zum Schluss nenne ich Ihnen noch unseren letztverstorbenen grossen Landsmann Mendelejeff den Schoepfer des periodischen Systems der Elemente. Ich nehme an, dass die Ehre, die Sie unserem Vaterlande soeben zugedacht, diese grossen Maenner wuerdigt. Wir sind die Erben der Taten, die diese Maenner ausgefuehrt haben. Kongresse werden nicht mit dem Kopfe allein gemacht. Auch das Herz hat dabei mitzureden. Wie weit ich mit dem Kopfe heranreichen kann, vermag ich natuerlich nicht zu urteilen. Was hingegen mein Herz anbetrifft, was hingegen alle die Wuensche betrifft, mein Bestes zu tun, Sie bestens zu empfangen, da glaube ich wohl sagen zu koennen, da will ich mich gerne und froehlich messen, mit den Herren die uns in den vorhergehenden Congressen empfangen haben und wenn ich nach drei Jahren imstande sein werde, mein Amt wieder neuen Haenden zu ueberreichen und mit dem sonnigen Humor vielleicht zu sprechen, wie unser gegenwaertiger Praesident, dann bin ich zufrieden. Ich danke Ihnen.

THE PRESIDENT: The next order will be the appointment of an organizing committee for that Congress, and before announcing the names decided upon by our friends in Russia and by the International Commission, I would like to put this matter to vote, that Professor Walden, the President of the Ninth Congress, shall be the Chairman of the organizing committee.

Carried unanimously.

The Russian Organizing Committee will be:

Grigori W. Chlopin, emeritus professor of physiological chemistry;

Alexsei I. Gorboff, president of the Chemical Section of the Imperial Technical Society and professor of chemistry;

Wladimir N. Ipatieff, professor of chemistry;

Peter S. Kossowitsch, emeritus professor of agricultural chemistry;

Nikolai S. Kournakoff, president of the Metallurgical Society and professor of chemistry;

Alexsei W. Ssaposchnikoff, professor of chemistry;

Wjatscheslaw E. Tischtschenko, professor of technical chemistry.

The President of the Ninth Congress will be much more competent than I, and this committee, all of whom reside in St. Petersburg, shall have power to add to their number.

I think we are to be congratulated upon this cordial invitation of Russia, and at any rate, from my own point of view, I shall look forward with the utmost pleasure at attendance at the Congress when I can take a side seat and notice how our good friend carries out the many duties which he knows he will have to perform.

The next business will be the matter of resolutions which have emanated from sections, and instead of asking the chairman of the sections to propose them, I have arranged with other members of the International Commission to bring them forward, with one or two exceptions.

At first, Section I: to the first resolution which you have printed before you in the four languages, I will ask Sir William Ramsay to speak.

Resolution I.

That the International Commission of Congresses of Applied Chemistry be requested to investigate through a sub-committee or otherwise the feasibility and practicability of adopting the International Auxiliary Language, Esperanto, as one of the official languages for use in the Ninth International Congress of Applied Chemistry, the investigating commission or committee to have full power to decide on the matter in the interval during the two Congresses, and to reach a decision at least one year previous to the opening of the Ninth Congress.

◆

Le hutième congrès international de chimie appliquée decide de charger:

La commission internationale des congrès de chimie appliquée d'étudier, soit chargeant de cette étude une sous-commission ou autrement, s'il est pratiquement possible d'adopter la langue internationale esperanto comme une des langues officielles du neuvième congrès international de chimie appliquée et de donner pleins pouvoirs à cet régard à la sous-commission de decider dans l'intervalle entre les deux congrès et moins un an avant l'ouverture du neuvième congrès.

◆

Dass die Internationale Kommission der Kongresse für angewandte Chemie beauftragt werde die Zweckmässigkeit und Brauchbarkeit der internationalen Hilfssprache, Esperanto, als einer der officiellen Sprachen für den neunten Internationalen Kongress für Angewandte Chemie, entweder durch einen besonderen Ausschuss oder auf sonstige angebrachte Weise zu untersuchen. Der Ausschuss soll bevollmächtigt sein, in der Zeit zwischen den zwei Kongressen darüber zu entscheiden und soll mindestens ein Jahr vor Eröffnung des neunten Kongresses diesbezügliche Beschlussnahmen bekannt machen.

◆

L'ottavo congresso di chimica applicata decide di incaricare la commissione internazionale dei congressi di chimica applicata di studiare a mezzo di un sotton comitato o altrimenti se sia practicamente possible adottare la lingua internazionale esperanto come una delle lingue ufficiali ammesse all'uso nel nono congresso internazionale di chimica applicata e di dare pieni poteri a detto comitato di decidere questa questione nell-intervallo fra i due congressi e almeno un anno prima dell'apertura del nono congresso.

SIR WILLIAM RAMSAY: *Mr. President, Ladies and Gentlemen:* This is a question of an international language, and it is proposed that an investigating commission or committee shall be appointed to have full power to decide on the question of an international language in the interval between the two congresses, to decide on the matter. It has appeared to the Committee of Presidents, to take such a step would be somewhat premature. Without arguing the question in any way, it has been agreed by the presidents to recommend this meeting to remit the question to the next Congress three years hence. It appears to me that this course is peculiarly advisable, because naturally the meeting here consists mostly of natives of this country. And it would be, I think, a mistake for Americans to dictate to the rest of the world the use of an international language. In Russia, on the other hand, a large number of nations will be gathered together. It will be said also that meeting in a country like Russia, speaking a language which is for the most part unknown to the members of the Congress, necessity for an international language may impress itself upon the members present more than it has upon this meeting. I therefore have to suggest that this proposal be remitted to the next Congress, meeting in St. Petersburg in 1915.

THE PRESIDENT: Of course the International Commission has no right to dictate, but after careful consideration that is the unanimous opinion of the Commission. Shall we have this discussed in some other language?

Sir William Ramsay's remarks were repeated in French.

THE PRESIDENT: Do you wish to hear it in German? If you do, hold up your hands.

(No repetition in German.)

THE PRESIDENT: The vote will be on the proposition of the International Commission as stated by Sir William Ramsay, to refer this to the next Congress, rather than to a Committee with power between the two congresses.

(A vote was taken by show of hands, and the President declared it carried.)

THE PRESIDENT: The next is from this same section, Resolution II. The first part (a) will be spoken to by Sir William Ramsay, and the second (b) by Dr. Morley who will express the views of the International Commission.

Resolution II

(a) *For commercial purposes an atomic weight table should be prepared only once in five years, put into use and be considered a general standard. It should always become effective at a fixed date.*

(b) *The section of analytical chemistry of the "Verein deutscher Chemiker" proposes that the question of uniform sampling of ores should be considered by the appropriate sub-committee of the International Committee on Analysis.* (*See p.* 221.)

◆

(*a*) *Pour la pratique, on ne devrait établir que tous les cinq ans un tableau des poids atomiques lequel sera généralement appliqué et fera loi dans les relations des chimistes entre eux. Il devrait entrer chaque fois en vigneur à partir d'un jour déterminé.*

(*b*) *Le groupe de chimie analytique de la Société des chimistes allemands demande que la question de l'analyse suivie d'échantillons de minerais soit remaniée sur des bases plus larges de la part de la sous-commission correspondante de la commission d'analyse internationale.* (cf. p. 221.)

◆

(*a*) *Für praktische Zwecke soll nur alle 5 Jahre eine Atomgewichtstabelle aufgestellt, allgemein angewandt und im gegenseitigen Verkehr als massgebend angesehen werden. Dieselbe soll jeweils von einem bestimmten Tage an gelten.*

(*b*) *Die Fachgruppe für analytische Chemie des Vereins deutscher Chemiker beantragt, dass die Frage der einheitlichen Probenahme von Erzen von der entsprechenden Subkommission der internationalen Analysenkommission auf breiterer Basis bearbeitet wird.* (cf. p. 221.)

◆

(*a*) *Una tavoletta dei pesi di atomi deve esser fatta pei fini practici una volta ogni cinque anni; questa deve unversalmente essere applicata come competente nelle re-*

> *lazioni reciproche tra le genti. La validità della stessa deve cominciare sempre da un dato giorno.*
>
> (*b*) *Il gruppo dei specialisti per la chimica analitica dell'Associazione dei chimici tedeschi propone, che la questione dell' is pezione delle miniere unificata debbe esser discussa ed elaborata su basi piu larghe della relativa sottocommissione del* comitato *internazionale per l'analisi.* (cf. p. 221.)

Sir William Ramsay: I think Dr. Nichols has made it sufficiently clear that the International Commission do not want in any way whatever, to force their views upon the Congress. But perhaps it may guide the members of the Congress to express an opinion, if I merely state, in one or two words, the present condition. It is suggested that for commercial purposes, a table of atomic weights should be prepared only once in five years, put into use, and considered a general standard. It shall always become effective at a fixed date. I think it is known to every one present, that there is an annual report by an International Committee upon atomic weights; that this report is issued at the beginning of the year; that it is obtainable for nothing by application; that it is published as an insert in practically every chemical journal. So that as regards atomic weights, they are revised annually. It appears to us that it would be a mistake to superimpose upon this annual table, which is already international, a second table defining atomic weights once every five years. I concede that for commercial purposes, the buyers and sellers of chemicals may not wish to have to alter their methods every year. On the other hand, I will point out that the atomic weights of most elements are now perfectly well known and extremely unlikely to be disturbed. We therefore, for this reason, suggest that this resolution shall not be passed.

The President: Do you sufficiently understand, or shall we have it discussed in some other language?

(Sir William Ramsay's remarks were repeated in French.)

Professor Hillebrand: I think it should be made known to the members assembled, and to the Congress, that this is a resolution which was prepared by the Verein deutscher Chemiker. It therefore has the backing of a commercial body. I think it has received attention also from a body of men in this country, and that Dr. Joseph W. Richards desires to present the testimony of commercial men, so far as he is acquainted.

DR. JOSEPH W. RICHARDS: Speaking for some of the commercial interests of America, I may say that this is very much desired, this table every five years. It is because the table corrected once every year introduces too much confusion in the commercial work, and too frequently. I know some of the commercial interests are in favor of having this motion passed. I would also say, as Secretary of the American Electro Chemical Society, that the Board of Directors of the American Electro Chemical Society last Monday night unanimously approved of this, and recommended to the Congress that it should be passed.

PROFESSOR F. W. CLARKE: *Mr. President, Ladies and Gentlemen:* As chairman of the International Commission on Atomic Weights, it is proper for me to say that the committee was organized by the concurrent action of all the great chemical societies of the world, and is now under the supervision of the International Association of Chemical Societies. It reports, therefore, and we received instructions from the International Association of Chemical Societies, which I have no doubt will pay due attention to the wishes of this Congress. Any resolution passed here upon this subject, therefore, will be recommendatory and not mandatory.

There is something to be said on both sides of the question. I think it is desirable that there should be a certain amount of constancy in the atomic weights used for legal purposes, where legal controversies may be involved; and it might be well to have a fixed list for temporary use for four or five years' use, or a three years' term, as has been requested. On the other hand, the men who are working with atomic weights on a scientific side, need the best and latest data, they need the very best figures that can be given. I suspect that the solution of the problem will be, therefore, for the commercial chemists to adopt as commercial chemists, the table of 1912, or the table of 1913, which is already prepared, and which involves no appreciable changes, it will be well for them to adopt that in the industrial circles, and leave the purely scientific side to the judgment of the men who are using the atomic weights for scientific purposes.

(These remarks are repeated in French and German.)

Dr. Duisberg: *Meine Herren:* Es liegt, glaube ich, ein Misverstaendnis vor. Es handelt sich hier nicht darum darueber zu entscheiden, ob die Internationale Atomgewichts-Kongresse, ihre Arbeit alle Jahre fortsetzen soll, sondern die Ansicht herrscht (und das war die Voraussetzung bei der Beschlussfassung in diesem Jahre des Vereins Deutscher-Chemiker in Freiburg) dass wenn die Kongresse alle 5 Jahre stattfinden werden, wie wir es gerne gesehen haben wuerden (und es hoffentlich so kommen wird) dass dann der Zeitpunkt dieses Kongresses massgebend sein soll fuer eine Tabelle fuer alle commerciellen Zwecke aber nicht massgebend sein soll fuer wissenschaftliche Zwecke. In diesem Beschluss werden wir gestuetzt von allen Herren, die in dem Dienste der Gerichte stehen, weil immer wieder Verwirrungen und Misverstaendnisse hervortreten, und um hier Einheit zu schaffen wuenschten wir gerne dass der Kongress beschliessen moechte, einen gewissen Zeitpunkt festzusetzen. Wollen Sie nicht 5 Jahre, dann nehmen Sie 3 Jahre, aber ich moechte sehr bitten, diesen Antrag anzunehmen, der, ich wiederhole es, nicht fuer wissenschaftliche Zwecke bestimmt ist, sondern fuer commercielle Zwecke, und der nur dahingeht, dass am Tage des Kongresses eine Tabelle aufgestellt wird, die bis zu dem naechsten Kongress in 3 oder 5 Jahren Giltigkeit hat.

Professor Giuseppe Oddo: Io credo che la proposta, dei Dottori di chimica applicata, di pubblicare la tavola dei pesi atomici, da servire per la chimica industriale, dopo un certo numero di 4, o 5 anni, non solo si debba accettare per la chimica applicata, ma si debba anche estendere alla chimica pura, perchè credo che da un anno all'altro per quanto valorose siano le persone che sono chiamate a fare la verifica, riesce sempre intempestivo, poichè da un anno all'altro le cose mutano.

Pregherei perciò la Commissione Internazionale di accordare un certo lasso di tempo, affinchè questa critica sui lavori chimici possa essere fatta con maggiore coscienza con maggiore tempo e perciò la proposta dei cultori di chimica applicata sia estesa anche alla chimica pura. Quello di voler modificare ogni anno è perfettamente una esagerazione e porterebbe svantaggio al nostro sviluppo, alla nostra scienza.

THE PRESIDENT: Are there any others who desire to speak?

DR. CLARKE: I offer an amendment or substitute for the motion. That it is the desire of this Congress that the International table for 1912, which is already extant, shall be regarded for commercial purposes as the official table until the next Congress convenes.

(This was repeated in French.)

THE PRESIDENT: We will vote upon Dr. Clarke's substitute motion unless there are objections. As many as are in favor of Dr. Clarke's substitute motion will signify it by raising the hand.

(Vote taken.)

THE PRESIDENT: That is a vote, and I think it seems to be quite satisfactory to everybody.

Dr. Morley will take up the next matter (section b of resolution II, p. 212), which I don't think will take quite so long.

DR. MORLEY: *Mr. President, Ladies and Gentlemen:* The Section of Analytical Chemistry of the Verein deutscher Chemiker proposes that the question of uniform sampling of ores should be considered by the appropriate sub-committee of the International Committee on Analyses. The methods of analysis of ores are reasonably satisfactory, and are accessible to all. The methods for uniform sampling are less satisfactory, in that methods are now published and accessible to all. The greater interest is now how to sample ores, but the lesser interests are trebled by differences of one half per cent and one per cent and two per cent and three per cent. Now the International Committee of Analyses should study this question. We don't dictate what their conclusions shall be, but the International Commission of the Congresses is unanimously of the opinion that we should refer this question, at the invitation of the Verein deutscher Chemiker to that committee already existing.

THE PRESIDENT: Are there any remarks?

PROFESSOR J. W. RICHARDS: At the request of the chairman of the section on Fuels, I would propose that the words "and fuels" be added to this resolution, so that the sampling of ores and fuels be of equal importance.

The President: Very much in the same category. They naturally go together. No objection whatever on the part of anybody. A very excellent addition. All in favor signify by a rising vote. To the contrary. That is a vote.

Now we come to the third, which you will find on page 1 of the English, and so on, and Professor Lindet will speak for the Commission.

Resolution III

Section I. of the Eighth International Congress of Applied Chemistry recommends that at this Congress and future Congresses the reports of the International Commission of Analyses and of other Committees appointed under the auspices of these Congresses, be printed in the transactions of the Congress, similarly to other contributions, according to the precedent of previous Congresses and in order to give results obtained by co-operation the same publicity as those of individual workers.

◆

La Section I. du 8ième Int. Congrès de la chimie appliquée demande, que les rapports de la Commission Internationale d'Analyses et d'autres commissions nominées par les congrès de la chimie appliquée soient imprimes aussi bien par le 8ième Congrès, que par les futures congrès au même tître que les autres communications aux Congrès, suivant l'usage des congrès anterieurs et afin de donner la même publicité aux resultats atteints par collaboration qu'à ceux obtenus par des contributeurs individuels.

◆

Die Section I. beantragt, dass die Berichte der Int. Analysenkommission und anderer von Kongressen für angewandte Chemie neidergesetzten Kommissionen in

den Verhandlungsberichten dieses 8ten Kongresses und künftiger Kongresse in ähnlicher Weise wie andere Beiträge gedruckt werden sollen, in Anlehnung an die Praxis früherer Kongresse und um den durch Kollektiv-Arbeit erzielten Resultaten dieselbe Verbreitung zu gewähren die den Beiträgen von Einzelpersonen.

◆

La Sezzione I. dell'èttavo Congresso della Chimica applicata domanda, che i rapporti della Commissione Internazionale di'Analisi e delle altre Commissioni nominate dai Congressi della Chimica Applicata siano stampati negli atti di Congresso, eguali alle altre communicazioni, per questo Ottavo Congresso e Congressi futuri a seconda del precedente dei Congressi anteriori, e per poter dare la stessa pubblicitá ai risultati ottenuto dalla cooperazione che quelli a dei lavoratori individuali.

PROFESSOR LINDET: Il s'agit, Mesdames et Messieurs, d'une simple affaire intérieure.

Jusqu'ici les rapports de la Commission Internationale des analyses étaient imprimés par mes soins, sur un crédit que je demandais au précédent Congrès.

Il s'agit, pour donner plus de publicité aux rapports de cette Commission Internationale d'analyses de charger le Congrès dorénavant d'imprimer les rapports, et nous demandons alors que le crédit que l'on m'allouait soit diminué de la somme qui représentait les frais de l'impression faits par moi.

La Section 1 du 8ème International Congrès demande que les rapports de la Commission Internationale des Analyses présidés par M. Lindet, soient imprimés aussi bien par le 9ème Congrès que par les futurs Congrès au même tître que les autres communications afin de donner la même publicité aux résultats obtenus en collaboration qu'à ceux obtenus par des chimistes travaillant individuellement. Pour éviter de trop gros frais de publicité, je m'engage, que la totalité des rapports ne dépasse pas 200 pages.

Dans le cas où des rapports trop importants seraient soumis

au président, il en référerait au Comité des Anciens Présidents. (Resolution II read in English, French, German and Italian.)

THE PRESIDENT: Are there any others who desire to speak?

> "And in addition that the sum of a thousand francs be granted for the work of that committee."

As many as are in favor will signify by raising the hands. You all understand it; very simple. To the contrary? That is a vote.

I am going to ask Professor Lindet to now speak to the fourth resolution of that section.

Resolution IV

(*a*) *Section I of the International Congress deems it necessary that directions should be prepared for tests of hydrometers and other instruments for chemical investigation and that these directions be printed in the four official languages of the Congress.*

(*b*) *The Section furthermore is of opinion that tables covering the density and expansion of fluids and solutions should be prepared and be published internationally.*

(*c*) *To this end Sub-committee 3 of the International Committee on Analyses should be continued.*

(*d*) *That this Congress allow the sum of $600 to the International Committee on Analyses for the work mentioned in paragraphs* (*a*) *and* (*b*) *above.*

◆

(*a*) *La Section I. du Congrès International juge nécessaire que des prescriptions soient faites en rapport aux épreuves des hydromètres et instruments pour analyses chimiques, et que ces prescriptions soient imprimées dans les quatre langues officelles du Congrès.*

(*b*) *La Section est aussi de l'opinion que des tableaux devront être faits sur la densité et l'expansion des fluides et solutions, et que ceux-ci devront être publiés internationalement.*

(c) Dans ce but, la Sous-Commission 3. Internationale des analyses existera encore quelque temps.

(d) Le Congrès voudra bien allouer la somme de $600 —à la Commission Internationale des Analyses pour les travaux mentilnnés dans les paragraphes (a) et (b) de ces resolutions.

◆

(a) Die Section I. des Internationalen Kongresses haelt es fuer noetig, dass die Vorschriften fuer Pruefung der Hydrometer und Geraete fuer chemische Untersuchungen ausgearbeitet und in den ier offiziellen Sprachen des Kongresses gedruckt werden.

(b) Sie haelt es ferner fuer noetig, dass Tabellen ueber die Dichte und die Ausdehnung von Fluessigkeiten und Loesungen ausgearbeitet und international veroeffentlicht werden.

(c) Zu diesem Behufe soll die Subkommission 3 der Kommission fuer Chemische Analysen noch weiter bestehen bleiben.

(d) Der Kongress moege der Internationalen Analysenkommission eine Summe von 600 Dollar zur Foerderung der unter (a) und (b) bezeichneten Arbeiten bewilligen.

◆

(a) La Sezzione I. del Congresso Internazionale crede, sia necessario che direzioni siano date per l'esame degli idrometri ed altri istrumenti che servono per investigazioni chimiche e che queste Direzioni siano emanate nelle quattro lingue ufficiali del Congresso.

(b) La Sezzione inoltre è dell-opinione che le tesi a riguardo della densità ed espansione dei fluidi e soluzioni siano stampate e pubblicato internazionalmente.

(c) A questo scopo il sottocomitato del Comitato Internazionale su Analisi, dovrebbe continuare ancora per quache tempto.

(d) Il Congresso gentilmente offre la somma di $600 alla Commissione Analitica per il lavoro menzionato nei paragrafi (a) e (b) du questa risoluzione.

Professor Lindet: Le Comité des anciens présidents considère que les éléments qui permettent de controler les aéromètres et autres instruments de mesure, relèvent plutôt de la Commission Internationale des "Constantes Physiques" qui a été nommée par le Congrès de Londres en 1909, qui a depuis fonctionné régulièrement et qui est subventionnée par les différentes académies et les différents Gouvernements.

Dans ces conditions, le Comité ne peut accorder à la Commission Internationale des analyses pour l'étude spéciale des aéromètres, etc. . . . la subvention demandée par la Section 1. du Congrès.

(Professor Lindet's remarks were repeated in German and in Italian.)

The President: Are there any further remarks? The motion is on the recommendation of the Commission that the appropriation be not granted. As many as are in favor signify by raising their hands. Contrary minded? It is a vote.

Dr. Richards has just reminded me, and I would like the stenographer to make note of this in the former resolution, that he wishes also to include metals. He was so anxious to include fuel for his friend, that he forgot metals for himself. If nobody objects, that will be entered after the former resolution, "In the sampling of ores, metals and fuels." I see no objection. That will be a vote. (See pp. 212.)

Resolution V offered by Section III: I will ask Mr. Snelling to state the situation very briefly.

Resolution V

The final report of the Commission Internationale pour l'Étude de l'Unification des Méthodes d'épreuves sur la Stabilité des Explosifs is received, accepted and approved, and the Commission is discharged, with thanks for their services.

It is further recommended that a permanent Committee of European experts be appointed, to bring these regulations to the attention of their respective governments, and to urge their adoption.

And it is further recommended that the report in French submitted by this Commission be printed in full, together with the English translation of the recommendations submitted by the President of the Commission.

◆

Le rapport final de la Commission Internationale pour l'Étude de l'Unification des Méthodes d'épreuves sur la Stabilité des Explosifs est reçu, accepté et approuvé et la Commission est déchargée avec remerciments pour ses services.

De plus, il est recommandé, qu'une Commission permanente d'experts Européens soit nommée, pour porter ces regulations à l'attention de leurs gouvernements respectifs, et d'en soigner l'adoption.

De plus, il est recommandé, que le rapport Français soumis par ce Comité soit imprimé complètement, en même temps que la traduction anglaise de ces recommandations soumises par le Président de cette Commission.

◆

Der Schlussbericht der Commission Internationale pour l'Étude de l'Unification des Methodes d'Epreuves sur la Stabilité des Explosifs ist angenommen und gebilligt worden und die Kommission wird mit Dank fuer ihre Dienste entlassen.

Es wird ferner empfohlen, dass ein permanentes Komittee von europaeischen Experten einberufen wird, um diese Bestimmungen der Aufmerksamkeit ihrer relativen Regierungen zu empfehlen und dern Annahme dringend zu befuerworten.

Und es wird ferner empfohlen, dass der von dieser Kommission gelieferte franzoesische Bericht ganz gedruckt wird zusammen mit der englischen Uebersetzung der Vorschlaege, die von dem Praesidenten der Kommission unterbreitet worden sind.

◆

> *Il rapporto finale della Commissione Internazionale per lo Studio dell-Unificazione dei Metodi di prova sulla Stabilità degli Esplosivi é stato ricevuto, accettato ed approvato e la Commissione viene licenziata con infiniti ringraziamenti per i loro servigi.*
>
> *È inoltre raccomandato, che sia nominato un Comitato composto di esperti Europei, che portino queste regole all'-attenzione dei rispettivi Governi sollecitandone l'adozione.*
>
> *È raccomandato infine che il rapporto in France-ce sottomesso dalla Commissione suddetta venga stampato per intero, assieme alla traduzione in Inglese delle raccomandazioni sottomesse dal Presidente della Commissione.*

Mr. Snelling: *Mr. President, Members of the Congress;* On the resolution that the final report of the Commission Internationale pour l'Étude de l'Unification des Méthodes d'épreuves sur la Stabilité des Explosifs is received, accepted and approved, and the Commission is discharged, with thanks for their services. It is further recommended that a permanent committee of European experts be appointed to bring these regulations to the attention of their respective governments, and to urge their adoption;

And it is further recommended that the report in French of the Commission be printed in full, together with the English translation of the recommendations submitted by the President of the Commission.

The President: The International Commission approves of this. Are there any remarks to be made? All those in favor will signify by raising the hand. Contrary minded? It is a vote.

Resolution VI

> (*a*) *That the disinfectants used in different countries should be controlled by a simple bacterial test capable of being easily effected, and that a Committee from this Congress do confer with a committee of the International Hygiene Congress to define such test.*
>
> (*b*) *That the President of the International Congress*

of Applied Chemistry be requested to appoint a Committee of three to represent this Congress for this purpose.

(*c*) *That the International Congress of Hygiene and Demography be invited to appoint a similar Committee.*

◆

(*a*) *Que les désinfectants employés dans les divers pays soient contrôlés par une simple épreuve bactériologique, qui peut être effectuée aisément, et qu'un Comité du Congrès confère avec un Comité du Congrès International d'Hygiène pour déffnir cette épreuve.*

(*b*) *Que le président du Congrès International de Chimie appliquée soit prié de nommer un Comité de trois membres pour représenter ce Congrès à cet effet.*

(*c*) *Que le Congrès International d'Hygiéne et de Démographie soit incité à nommer un Comité similaire.*

◆

(*a*) *Dass die in den verschiedenen Laendern gebrauchten Desinfektionsmittel durch eine einfache bakteriologische Pruefung kontrolliert werden, die leicht vorgenommen werden kann, und dass eine Kommission dieses Kongresses mit einem Komité des Internationalen Hygiene-Kongresses konferirt und die Art einer solchen Pruefung bestimmt.*

(*b*) *Dass der Praesident des Internationalen Kongresses fuer angewandte Chemie ersucht wird, ein Komité von 3 Mitgiledern zu bestellen, das diesen Kongress fuer diesen Zweck vertreten soll.*

(*c*) *Dass der Internationale Kongress fuer Hygiene und Demographie aufgefordert werde, ein aehnliches Komité zusammentreten zu lassen.*

◆

(*a*) *Che i disinfettanti usati nei diversi paesi siano tutti controllati da una sola prova batteriologica, che possa facilmente effettuarsi, e che un Comitato di-questo Congresso conferisca col Comitato del Congresso Internazionale de Igiene, per definire una tale prova.*

> *(b) Che il Presidente del Congresso Internazionale su Chimica Applicata sia pregato di nominare un Comitato di tre membri, che rappresenti il presente Congresso a tal scopo.*
>
> *(c) Che il Congresso Internazionale di Igiene e Demografia sia invitato a nominare un Comitato come sopra detto.*

This resolution as placed here is approved by the International Committee. Are there any others who desire to speak upon it? If not, those in favor of the present resolution will signify by saying "Aye"?

(Chorus of voices: Aye.)

The President: Contrary no. It is carried.

Now this arranges for the assignment of a committee of three, and if you have no objection I will appoint that committee, and will give the names handed me by the section presidents. Have you any objection? I would appoint

1. Karl Imhoff, Essen, Germany.
2. Samuel Rideal, London, England.
3. Earl B. Phelps, New York City.

Is that satisfactory?

Carried unanimously.

Resolution VII offered by Section VIIIc: Mr. Lindet will present it.

Resolution VII

> *That the International Committee of Analytical Methods for Food Products shall continue its work and that the sum of Six Hundred Dollars ($600.00) be appropriated for that purpose.*

◆

> *Le VIII Congrès International de Chimie appliquée demandé que la Commission Internationale d'unification des méthodes d'analyse des Denrées alimentaires continue ses travaux et que le Congrès lui donne $600 pour ce but.*

◆

> *Der VIII Internationale Kongress fuer angewandte Chemie wolle beschliessen, dass die Internationale Kommission fuer einheitliche Untersuch ungsmethoden der Nahrungsmittel mit der Fortsetzung ihrer Arbeiten beauftragt und ihr hierfuer die Summe von 600 Dollars zur Verfuegung gestellt wirde.*

◆

> *Che il Comitato Internazionale di Metodi Analitichi per prodotti alimentari continuerá il suo lavoro e che la somma di Seicento dollari ($600.00) viene data dal Congresso per questo fine.*

PROFESSOR LINDET: *Messieurs:* Il s'agit d'appliquer à la Commission présidée par M. von Buchka, qui a pour but l'unification des méthodes d'analyse des matières alimentaires aux mêmes règles, que celles, qui ont été appliquées à la Commission présidée par M. Lindet.

Le Comité décide d'appliquer à la Commission Internationale des analyses pour les produits alimentaires présidée par M. le Dr. von Buchka la même règle qui a imposée à la Commission Internationale des analyses qui est présidée par M. Lindet.

De plus, le Comité demande pour M. von Buchka le même crédit que pour moi, c'est-à-dire la somme de 1.000 francs ou de $200.—

THE PRESIDENT: Is that satisfactory to Dr. von Buchka?

DR. VON BUCHKA: Yes, I am quite satisfied with it.

THE PRESIDENT: It is very simple, and ends up with the appropriation of a thousand francs, or two hundred dollars, the same as for the Committee under the Presidency of Monsieur Lindet. Are there any who desire to speak? If not, as many as are in favor raise their hand. Contrary minded? It is a vote.

The next is Resolution VIII, Section XI, which will be presented by Monsieur Lindet:

Resolution VIII

> (*a*) *That Sub-committee XI. of the International Committee on Analyses shall continue its work of inquiry into*

special cases having international interest in which reason for a unification of analytical methods for organic coloring matter exists.

(*b*) *That the International Committee on Analyses shall suggest that all Governments adopt identical regulations concerning the organic coloring matters whose use in food products is to be permitted or forbidden, and that it shall further propose the adoption of uniform analytical methods required in connection with such regulations.*

(*c*) *That Sub-committee XI. of the International Committee on Analyses shall appoint a committee (limited to three or five members) to examine ways and means to secure, with the co-operation of the manufacturers, information concerning the reactions and analysis of recently introduced organic coloring matters, to bring about a suitable publication of results, and to present a report on the same to the next Congress.*

◆

(*a*) *Que la Sous-Commission XI. du Comité International des Analyses poursuivra ses travaux d'inquistion dans des cas spéciaux ou l'unification de méthodes analitiques pour la chimie des matières colorantes organiques peut présenter un intérêt international.*

(*b*) *Que la Commission Internationale d'analyses fasse la suggestion, que tous les Gouvernements adoptent des régulations identiques en rapport aux matières colorantes organiques, l'usage desquelles est permis ou défendu dans les denrées alimentaires, et qu'elle propose également l'adoption de méthodes analytiques uniformes nécessaires en rapport avec ces régulations.*

(*c*) *Que la Sous-Commission XI. de la Commission Internationale d'analyses denominera un comité (limite à trois ou cinq membres), dans le but d'examiner, de concert avec les fabricants, les moyens pour obtenir des informations rélativement aux réactions et analyses de matières colorantes organiques introduites récemment, de manière*

à produire une publication appropriés des resultats, et d'en presenter un réport au Congrès prochain.

◆

(*a*) *Dass die Unterkommission XI. der Internationalen Analysen-Kommission ihre Untersuchungsarbeit an besonderen Faellen von internationaler Bedeutung fortsetzen soll, fuer welche Faelle eine Vereinbarung der analytischen Methoden der organischen Farbstoffe moeglich ist.*

(*b*) *Dass die Internationale Analysen-Kommission die Regierungen aller Laender ersuchen soll, gleichmaessige Vorschriften in Bezug derjenigen organischen Farbstoffe zu machen, fuer welche eine Erlaubnis oder ein Verbot in der Anwendung fuer Lebensmittel verhanden ist; und dass fernerhin die Kommission die Annahme von gleichmaessigen analytischen Methoden fuer solche Vorschriften vorschlagen soll.*

(*c*) *Dass die Unterkommission XI. der Internationalen Analysen-Kommission eine besondere Kommission (von 3 bis 5 Mitgliedern) ernennen soll mit der Aufgabe, in Gemeinschaft mit Fabrikanten Mittel und Wege, in Bezug auf die Reaktionen und Analysen der neueren organischen Farbstoffe zu ermitteln, passende Veroeffentlichungen der vorhandenen Resultate zu machen und einen vollen Bericht derselben an den naechsten Kongress zu erstatten.*

◆

(*a*) *Che il Sub-Comitato XI. del Comitato Internazionale su Analisi, continuerá il suo lavoro d'inchiesta, in quei casi speciali, dove vi é ragione per un interesse internazionale, per l'unificazione dei metodi di analisi, nelle materie organiche colorate.*

(*b*) *Che il Comitato Internazionale su Analisi suggerisca che tutti i Governi adottino regole identiche, a riguardo delle materie organiche colorate, il cui uso viene permesso o proibito in prodotti alimintati, e proporre inoltre che metodi uniformi di analisi, siano adottati in connezione con le regole suddette.*

(c) Che il Sub-Comitato XI. del Comitato Internazionale su Analisi, nomini un Comitato (limitato a 3 o 5 membri), per esaminare e discutere i vari mezzi, onde poter ottenere, con la cooperazione dei fabbricanti, informazioni concernenti l'analisi di materi organiche colorate, recentemente introdotte, pubblicarne i risultati e presentare un rapporto dei suddetti resultati al prossimo Congresso.

Professor Lindet: Il s'agit, Messieurs, d'une question encore intérieure.

A la Commission Internationale des analyses, il y a eu une Section, la Section 11 de la Commission Internationale des analyses qui a émis le voeu suivant:

Que la Sous-Commission 11, (page 3 en français) pour-suivra ses travaux d'inquisition dans des cas spéciaux ou l'unification des méthodes analytiques pour la chimie, des matières colorantes organiques peut présenter un intérêt international.

Que la Commission Internationale fasse la suggestion que tous les gouvernments adoptent des régulations identiques en rapport aux matières colorantes organiques, l'usage desquelles est permis ou défendu dans les denrées alimentaires, et qu'elle propose également l'adoption de méthodes analytiques uniformes nécessaires en rapport avec ces régulations.

Que la Sous-Commission 11 de la Commission Internationale d'analyses dénominera un comité (limité à 3 ou 5 membres) dans le but d'examiner, de concert avec les fabricants, les moyens pour obtenir des informations relativement aux réactions et analyses de matières colorantes organiques introduites récement, de manière à produire une publication appropriée des résultats, et d'en présenter un rapport au Congrès prochain.

La question a été discutée à — du Congrès.

La Section 1 et la Section 2 présidées par M. et les membres présents ont été unanimes pour admettre ces 3 règles que je viens de faire connaitre.

The President: Are there any objections to that? If not, as many as are in favor will raise their hands. Contrary minded? It is a vote.

The next resolution, and the last one printed here, is rather

long, and I will not read it, because you have it in your hand. It is the unanimous opinion of the International Committee, and it also was the opinion of the Executive Committee of this Congress, who discussed it many times, that the matter suggested is absolutely impracticable, and the Commission recommends that this resolution be not adopted. Are there any who desire to speak on that subject?

Resolution IX

The future Congresses of Applied Chemistry shall examine and report upon the progress and position of chemical industry in each of the countries represented at the preceding Congress, having particular regard to the relation between the development in the different branches of chemical industry and custom tariffs.

For this purpose the Executive Committee of the IXth Congres shall be entrusted with the drawing up of such a report of the development of chemical industry in that country where the said Congress is to be held. This report, based on the existing statistical and historical facts, is to appear a year before the meeting of the Congress, and after its issue experts in different countries shall be entrusted by the Section with the work of drawing up similar reports on the development of chemical industry in their respective countries. These reports would comprise an authoritative source of information as to the condition of chemical industries throughout the world.

The Congress hopes that the Governments of the different countries will further this work, which is of high importance to the estimation of the effects of the existing commercial policy and to the renewal of commercial treaties.

◆

Les futurs Congrès de Chimie Appliquée examineront et feront un rapport sur l'état et les progrès des industriès chimiques dans chaque pays représenté au Congrès

précédent, étudiant tout particulièrement le rapport qui existe entre le dévéloppement des différentes branches de l'industrie chimique et les tarifs douaniers.

A ce but, le Comité executif du IX. Congrès sera chargé d'un rapport sur le dévéloppement de l'industrie chimique du pays où le dit Congrès aura lieu. Ce rapport basé sur les données statistiques et historiques existantes devra paraître un an avant l'assemblée du Congrès. Après sa publication, la Section chargera des experts de différente pays de l'élaboration de pareils rapports su le dévéloppement se l'industrie chimique de leurs pays. Ces rapports seront une source authentique d'information sur les conditions des industries chimiques du monde.

Le Congrès espère que les Gouvernements des différents pays favoriseront ce travail important pour l'estimation des effects de la politique douanière actuelle ainsi que pour le renouvellement des traités commerciaux.

◆

Die naechsten internationalen Kongresse fuer angewandte Chemie werden ueber den Stand und die Entwicklung der chemischen Industrie in allen Laendern, welche bei dem vorangegangenen Kongresse vertreten waren, eingehend berichten. Die Berichterstattung wird auf den Zusammen hang zwischen der Zolltarifgesetzgebung und der Entwicklung der verschiedenen Zweige der chemischen Industrie besonderes Gewicht legen.

Zu diesem Behufe wird das Vorbereitungs-Komittee des IX. Kongresses mit der Aufgabe betraut, ueber die Entwicklung der chemischen Industrie in jenem Lande, in welchem der erwaehnte Kongress stattfinden wird, einen eingehenden Gericht zu erstatten. Dieser Bericht, welcher sich auf die vorhandenen statistischen und historischen Tatsachen stuetzen wird, soll ein jahr vor dem Zusammentritt des IX. Kongresses erscheinen. Nach der Herausgabe dieses Berichtes soll die Sektion in den verschiedenen Laendern Fach-Experten damit betrauen,

aehnliche Verichte ueber die Entwicklung der chemischen Industrie in ihren Laendern auszuarbeiten. Die Berichte sollen in ihrer Gesamtheit eine verlaessliche Quelle von Informationen ueber die Entwicklungsbedingungen der chemischen Industrie in beiden Weltteilen darstellen.

Der Kongress giebt der Hoffnung Ausdruck, dass die Regierungen der verschiedenen Staaten dieses Werk, welches von hoher Bedeutung fuer die Beurgheilung der Ergebnisse der gegenwärtigen Handelspolitik und fuer die Erneuerung der Handelsvertraege ist, ihrerseits unterstuetzen und foerdern werden.

◆

I futuri congressi di Chimica Applicatoria esamineranno e feranno rapporto sullo stato ed i progressi delle industrie chimiche di tutti i paesi rappresentati al Congresso precedente studiando particolarmente il nesso esistente fra lo sviluppo dei differenti rami dell'industria chimica e le tariffe doganali.

A tale scopo il comitato esecutivo del XI. congresso serà incaricato di redigere un rapporto concernente lo sviluppo dell'industria chimica del paese ove il congresso avrà luogo.

Questo rapporto basato sulle date statistiche e storiche dovrà comparire un anno prima del unirsi del congresso. Dopo la publicazione dello stesso, la Sezione incaricherà degl'esperti dei differenti paesi della redazione di simili rapporti sullo sviluppo dell'industria chimica dei loro propri paesi.

Questi rapporti serviranno quale fonte d'informazione autentica delle condizioni dell'industrie chimiche del mondo.

Il Congresso spera che i Governi dei singoli paesi sosteranno guesto lavoro ugualmente importante per l'apprezziazione degl'efetti delle poltica doganale attuale e per il rinovamento dei trattati comerciali.

DR. GROSSMAN: *Meine Herren und Damen:* Bei dem vorigen Kongresse wurde der Vorschlag bereits gemacht, und auch angenommen, dass in dem Lande, wo ein internationaler Kongress stattfindet, auch ein Bericht ueber die industriellen Zustaende des Landes geliefert wird. Man hat in dem Berichte hier Verschiedenes ueber die chemische Industrie in den verschiedenen Staaten mit geteilt, und das ist auch sehr dankenswert. Wir erhielten ausserdem einen ausfuehrlichen Bericht von Kanada, den ich gerne der Aufmerksakeit der Herren empfehlen moechte. Ich glaube, es waere sehr wuenschenswert auch in Russland einen Bericht ueber die chemische Industrie einzuholen, und glaube ich dass dies die allgemeine Interesse haben wuerde; und moechte ich wissen, ob es nicht moeglich waere von der Russischen Regierung das Versprechen zu bekommen, dem Kongresse in Russland etwas ueber den Zustand der chemischen Industrie in Russland mitzuteilen.

PROFESSOR J. W. RICHARDS: *Mr. President, Members:* It may be interesting to know that in regard to this question the International Geological Congress made a long report concerning the countries in which the different Congresses have met, and it has been done voluntarily, and it has become the custom, and I believe if it were laid upon the committee as a duty, it would not be so well performed as if it were merely done as a custom.

THE PRESIDENT: Dr. Walden, would you give us your views? What would you propose?

HERR WALDEN: Ich meine, dass diese Sache eigentlich nicht gut von uns der Regierung vorgeschrieben werden kann. Wenn hier ein Beschluss gefasst werden kann, so kann das nur in Form eines Wunsches geschehen. Wir haben augenblicklich einen Verein in St. Petersburg, der die Hebung der chemischen Kunst ueberhaupt im Augebehaelt, und das was hier gewünscht wird, haben die Herren uns freiwillig berichtet, aber sie haben es freiwillig getan, und werden es nicht tun wenn wir beabsichtigen, es ihnen durch die Regierung aufzudraengen, denn "Man merkt die Absicht und wird verstimmt."

THE PRESIDENT: Of course it would be something you could not possibly do in the United States. If our friends in Russia wish it, why of course we can have no objection, but the Commission are of the opinion that it is impracticable, and I still continue to the same belief. We have heard Dr. Duisberg

speak for an hour and a half, and he only touched on a very few things, not one-fiftieth of what could be touched on, and how can we ask a committee, with the amount of work they have to do, to prepare something which would be something herculean in its proportions. However, if they wish to do it voluntarily, we would be delighted. As many as are in favor of the recommendation of the committee, signify by raising their hands. Contrary? Carried—that it will not be required of the next Congress, but anything they provide will be very welcome.

We now come to the proposals brought forward by the International Commission itself, and I am going to ask Dr. Strohmer to read the first resolution in German. You can all follow it in the other languages.

DR. STROHMER: *Meine Herren;* Herr Remington hat uns mehrere Vorschlaege vorgelegt, welche jedoch nicht rechtzeitig abgefasst wurden, um der Kommission zur Beschlussfassung vorgelegt zu verden.

Dass die Sektion VIIIb des VIII. Internationalen Kongresses fuer angewandte Chemie die Eignung der Internationalen Bestimmungen fuer Staerke, Reinheit, Art der Pruefung und Namenklatur fuer Pharmacopaeische Praeparate pruefe.

Beschlossen:

Nachdem Sektion VIIIb. (Pharmaceutische Chemie) des VIII. Internationalen Kongresses fuer angewandte Chemie den Bericht der Internationalen Kommission betreffs "Variation in der Aktivitaet der giftigen (Toxic) Droguen" erhalten und diskutiert hat, hat sie beschlossen, dass es wuenschenswert ist, dass das Studium dieser Frage fortgesetzt wird und dass die Internationale Kommission reformiert werde, indem sie aus den folgenden 8 Mitgliedern bestehe:

Oesterreich, Prof. Wilhelm Mitlacher; Frankreich, Prof. E. Bourquelot; Deutschland, Prof. H. Thoms; Gross Britannien, Francis Ransom; Niederlande, Prof. L. Van Itallic; Russland, W. Ferrein, Mag. Ph.; Schweiz, Prof. A. Tschirch; Vereinigte Staaten, Dr. R. H. True, und den folgenden drei Sekretaeren: G. P. Forester, F.C.S., Europeaischer Kontinent, Peter McEwan, F.C.S., Gross-Britannien; Otto Raubenheimer, Vereinigte Staaten.

Es wird ferner beschlossen, dass diese Kommission autorisiert wird, die Mitarbeit anderer Personen zu erwerben, die aktiv interessiert sind an der oeffentlich bekannt zu machenden internationalen Gleichheit der Bestimmungen fuer Pstarkwiskinde-Droguen und Verbesserung ihrer Kultivation und Kollektion.

Dass die Internationale Kommission der Kongresse fuer angewandte Chemie ersucht werde, die Organisation eines Komités, durch Joseph P. Remington, zu billigen, welches aus chemischen Experten mit Zustimmung der Kommission zusammengesetzt werden soll. Die Aufgabe dieses Komités soll sein, Information ueber chemische Produkte und fluechtige Oele, welche gegenwärtig in der Pharmacie im Gebrauch sind, aus jeder erreichbaren Quelle zu sammeln, ebenso ueber die gebraeuchlichen Pruefungen der Identitaet und Reinheit dieser Produkte und Oele; ferner, Typen und Pruefungsmethoden mit Ruecksicht auf eine Einheitlichkeit derselben fuer die ganze Welt in Betracht zu nehmen, und endlich ueber seine Arbeiten einen Bericht an den neunten Internationalen Kongress vorzulegen.

THE PRESIDENT: You have all read in your own languages, what Dr. Strohmer has read, I suppose. Are there any objections'? As many as are in favor will raise their hands.

Resolution X

(a) That Section VIIIb. of the Eighth International Congress of Applied Chemistry consider the feasibility of international standards of strength, purity, method of testing and nomenclature of pharmacopœial preparations.

(b) Section VIIIb. (Phramaceutical Chemistry) of the Eighth International Congress of Applied Chemistry having received and discussed the report of the International Commission on "Variation in the Activity of Toxic Drugs," resolves that it is desirable that this inquiry be continued and that the International Commission be reformed and to consist of the following eight members:

Austria, Prof. Wilhelm Mitlacher; France, Prof. E. Bourquelot, Germany, Prof. H. Thoms; Great Britain, Francis Ransom, Netherlands, Prof. L. Van Itallic; Russia, W. Ferrein, Mag. Th., Switzerland, Prof. A.

Tschirch, United States, Dr. R. H. True, and the following three secretaries; G. P. Forrester, F. C. S., European continent, Peter McEwan, F. C. S., Great Britain; Otto Raubenheimer, United States.

(*c*) *It is further resolved that this commission be authorized to enlist the co-operation of other persons actively interested in promulgating international uniformity of standards for potent drugs and improvement in their cultivation and collection.*

(*d*) *That the International Commission of Congresses of Applied Chemistry be requested to approve the organization of an international committee under Joseph P. Remington, and composed of chemical experts approved by this commission, whose duty shall be to collect information from every availble source on chemical products and the essential oils used in pharmacy, and to investigate the tests now in use to prove the identity and purity of said products and oils; also to consider standards and tests with the view of establishing uniformity in the same throughout the world, and to report at the Ninth International Congress the results of its work.*

◆

(*a*) *Que Section VIIIb. du VIII. Congrès International de Chimie appliquée considère la possibilité d'etablier des règles internationales sur la force, la pureté, la méthode d'épreuve et nomenclature de préparations pharmaceutiques.*

(*b*) *Section VIIb.* (*Chimie pharmaceutique*) *du VIII. Congrès International de Chimie appliquée, ayant reçu discuté le rapport de la Commission Internationale sur les "Variations dans l'activitè de drogues toxiques" décide qu'il est désirable que cette enquête soit continuée, et que la Commission Internationale soit réformée et comprenne les huit membres suivants:*

Autriche, Prof. Wilhelm Mitlacher; France, Prof. E. Bourquelot; Allemagne, Prof. H. Thoms: Grande Bretagne, Francis Ransom; Pays Bas, Prof. L. Van Itallic; Russie, W. Fererin, Mag. Ph.; Suissie, Prof. A. Tschirch;

Etates Unis, Dr. R. H. True, et les trois sécretaires suivants: G. P. Forrester, F. C. S., Continent Européen; Peter McEwan, F. C. S., Grande Bretagne; Otto Raubenheimer, Etats Unis.

(*c*) *De plus, il a été résolu que cette Commission soit autorisée à engager la co-opération d'autres personnes activement intéressées de promulguer une uniformité Internationale de règles pour les drogues forcées, et d'amélioration dans la culturet et la récolte des drogues.*

(*d*) *Que la Commission internationale des Congrès de Chimie appliquée soit priée d'approuver l'organisation d'un Comité, sous la présidence de Joseph P. Remington, et compose d'experts chimistes, agrées par cette Commission, et qui sera chargé de réunir les renseignements de toutes sources accessibles sur les produits chimiques et les huiles essentielles, employés en pharmacie, et de rechercher les méthodes d'épreuves en usage aujourd'hui pour établir l'identité et la pureté des produits et huiles en question; le comité consideréra les types-étalons et les méthodes dépreuves avec l'idée d'établir leur uniformité dans le monde entier et communiquera les résultats de ces travaux au neuvième Congrès de Chimie appliquée.*

◆

(*a*) *Dass die Sektion VIIIb. des VIII. Internationalen Kongresses fuer angewandte Chemie die Tunlichkeit der Internationalen Bestimmungen fuer Staerke, Reinheit, Art der Pruefung und Namenklatur fuer Pharmacopaeische Praeparate prueft.*

(*b*) *Nachdem Sektion VIIIb.* (*Pharmaceutische Chemie*) *des VIII. Internationalen Kongresses fuer angewandte Chemie den Bericht der International Kommission betreffs "Variation in der Aktivitaet der giftigen* (*Toxic*) *Droguen" erhalten und diskutiert hat, hat sie beschlossen, dass es wuenschenswert ist, das der Studium dieser Frage fortgesetzt wird und dass die Internationale Kommission reformiert werde, indem sie aus den folgenden 8 Mitgliedern bestehe:*

Oesterreich, Prof. Wilhelm Mitlacher; Frankreich, Prof. E. Bourquelot; Deutschland, Pro;. H. Thoms: Gross Britannien, Francis Ransom; Niederlande, Prof. L. Van Itallic; Russland, W. Ferrein, Mag.Ph.; Schweiz. Prof. A. Tschirch; Vereingte Staaten, Dr. R. H. True, und den folgenden drei Sekretaeren: G. P. Forester, F. C. S., Europaeischer Kontinent: Peter McEwan, F. C. S., Gross-Britannien; Otto Raubenheimer, Vereingte Staaten.

(*c*) *Es wird ferner beschlossen, dass diese Kommission autorisiert wird, die Mitarbeit anderer Personen zu worben, die aktiv interessiert sind an der oeffentlich bekannt zu machenden internationalen Gleichheit der Bestimmungen fuer starkwirkende Droguen und Verbesserung ihrer Kultivation und Kollektion.*

(*d*) *Dass die Internationale Kommission der Kongresse fuer Angewandte Chemie ersucht werde, die Organisation eines Komites, durch Joseph P. Remington, zu billigen, welche aus chemichen Experten mit zustimmung zusammengesetzt werden soll. Die Aufgabe dieses Komites soll sein, information ueber Chemike Produkte und fluechtiger Oele welche gegenwartig in der Pharmacie im gebrauch sind aus jeder erreichbaren Quelle zu sammeln, ebenso die gebrauchlichen Pruefungen der Identitaet und Reinheit dieser Produkte und Oele: ferner, Typen und Pruefungsmethoden mit Rücksicht auf eine Einheitlichkeit derselben fürdie ganze Welt in Betracht nehmen, und endlich über seine Arbeiten einen Bericht an den neunten Internationalen Kongress vorzulegen.*

◆

(*a*) *Che la Sezzione VIIIb. dell'VIII. Congresso Internazionale di Chimica Applicata consideri la possibilitá e l'effetuabilitá di regole internazionali di forza, purita, metodi di prova e nomenclatura per preparazione farmacopee.*

(*b*) *La Sezzione VIIIb. (Chimica Pharmaceutica) dell'8° Congresso Internazionale di Chimica Applicata*

avendo ricevuto e discusso il Rapporto della Commissione Internazionale sulla "Variazione nell'Attivita di Droghe Tossicose" risolve esser desiderabile che questa inchiesta venga continuata e che la Commissione Internazionale sia riformata in modo da consistere dei seguenti membri:

Austria, Prof. Wilhelm Mitlacher; Francia, Prof. E. Bourquelot; Germania, Prof. H. Thoms; Gran Brittagna, Prof. Francis Ransom; Netherlands, Prof. L. Van Ittalic; Russia, W. Ferrein, Mg.Ph.; Svizzera, Prof. A. Tschirch; Stati Uniti d'America, Dr. R. H. True ed i tre seguenti Segretari; G. P. Forrester, F. C. S., Continente Europeo; Peter McEwan, F. C. S., Gran Brittagna; Otto Raubenheimer, Stati Uniti.

(c) È stato inoltre risoluto che questa Commissione sia autorizzata d'ingagiare la co-operazione di altre persone attivamente interessate nel promuovere una uniformità internazionale di regole per droghe potente, ed il miglioramento nella loro coltivazione e collezione.

(d) Che la Commissione Internationale dei Congressi di Chimica Applicata venga richiesta di approbare l'organiz zazoine di un Comitato, sotto la presidenza di Joseph P. Remington, e composto di esperti chimici approbati dalla commissione, essendo questo Comitato incaricato di collettare informazioni da ogni possiblefonte, a rigurdo dei prodotti chimici e degli olii volatili impiegati nella farmacia, e di cercare i metodi di prova ora in uso per tsabilire la purita e l'identita dei sudetti prodotti ed olii; il Comitato studiara anche tipi ed i metodi di prova colla idea di stabilire la loro uniformita nel mondo intero, e dovra fare un rapporto dei suoi lavori al nono Congresso di Chimiac applicata.

PROFESSOR GIUSEPPE ODDO: In questo momento si è dimenticator di mettere un rappresentante dell'Italia. Ora siccome l'industria dieprodotti chimici in Italia è molto estesa e molti prodotti preparati in Italia vengono in American e vanno in altre Nazioni, chiedo sia nominato un rappresentante nell'industria Farmaceutica per l'Italia. Proporrei il Prof. Spiga dell'Università di Pavia.

THE PRESIDENT: Is that satisfactory to everybody? As many as are in favor, raise their hands. Contrary minded, no. I am very glad indeed, to correct such error for our good friends in Italy.

I am now going to ask Sir William Ramsay, to bring up a matter of considerable importance.

SIR WILLIAM RAMSAY: The matter I have to bring your attention next is the Tables of International Constants. At the seventh meeting in London, the committee was appointed to prepare a table of international constants, an annual table. Here is a volume—a year's work. It is called "Tables Annuelles Internationales de Constantes et Données Numériques, 1910." This undertaking has been stipulated by the governments of numerous countries, and by contributions from numerous societies. There is already a very considerable income promised for a very considerable time. It is for the object of assisting this Commission, that I wish to propose to you that a committee be appointed to go over the accounts of the treasurer of the International Commission, and the annual table of constants appointed and created by the Seventh Congress. I am reading here the resolutions which have been sent to me by the honorary committee. I should like to modify this suggestion by the addition of the following: "That the Treasurer of this Congress have the accounts sent to him." If he likes to ask a committee to help him go over them, very well, but it is due to this Congress that the accounts should be presented to the Congress, and it appears to me the right person to present them to is the present treasurer, who will deal with them as he sees fit. If he likes to send them on to the next Congress, good and well.

THE PRESIDENT: Are there any objections to that, or any better suggestions? I think that every one will agree that Mr. Matheson, when he has got through with his work, can take up something new. If there is anything wrong in the account he will find it.

SIR WILLIAM RAMSAY: The second suggestion is that the Eighth Congress of Applied Chemistry approve the work of the International Commission in London in 1909, and recognize the splendid importance of the work represented by the first volume of annual tables proposed by the International Commission, and express the wish that the International Commission receive such financial assistance from governments, academies, and societies and take whatever steps are necessary to continue the work of scientific tabulation. This resolution has for its object not to ask this Congress, or any future Congress for a grant, but to get the moral support of the Congress, so that in making application to societies and similar bodies, they can have the benefit of the approval of this Congress, and be able to go with a better face to the Congresses which are already contributing to smaller bodies. There is a third resolution proposed and any one who has studied this volume will see at once the enormous amount of work entailed, and it is due to the workers that this Congress should express its appreciation of that work.

THE PRESIDENT: There are two other volumes, I am told, in the press. It is a matter of enormous importance. Are there any remarks? As many as are in favor of these resolutions, raise their hand. They are very simple. Contrary minded? That is a vote.

I am now going to ask Dr. Morley to present another matter, which I believe will be brief.

MR. MORLEY: *Ladies and Gentlemen:* The years fly on, alas, even for chemists. Old age and infirmity do not long wait, and so it happens that the International Commission of Congresses of Applied Chemistry has lost the services of the Belgian member of the Commission, Monsieur Hanuise, who is no longer able to assist in its deliberations, and is unable even to respond to letters, and therefore this International Commission, unanimously proposes that the place of Monsieur Hanuise be filled by the appointment of M. François Sachs.

THE PRESIDENT: That is very simple and very important. Are there any remarks? As many as are in favor of Monsieur Sachs, of Belgium, being our very first Congress host, will signify it by raising the hand. Contrary minded, no. It is a vote.

Are there any other resolutions ready to be presented at this meeting? Dr. Kunz, I think, has some.

DR. KUNZ: The Eighth International Congress of Applied Chemistry gratefully acknowledges the hospitality, courtesy and substantial assistance of the many who have done so much to make this gathering enjoyable, instructive and profitable.

The Congress feels under especial obligations:

To the President of the United States for his devotion as the highest officer of the Congress, and for his great consideration in abandoning the comfort of his short vacation, to return to Washington to preside at the opening of the ceremonies, even under the strain of a painful personal injury.

For his reception and address in the White House, and for his personally meeting every Member of the Congress and their guests.

To Dr. Charles D. Walcott, Secretary, and the Board of Regents of the Smithsonian Institution for their courtesy in inviting the Members of the Eighth International Congress of Applied Chemistry, to their splendid reception on the evening of Wednesday, September 4th, 1912.

To Dr. Rathburn, Director of the Smithsonian Institution, for the splendid hospitality shown by the United States National Museum.

To the Daughters of the American Revolution for their courtesy in extending the use of the Continental Hall for the opening of the Congress at Washington.

To President Nicholas Murray Butler and the Board of Trustees of Columbia University for their great courtesy in extending the use of the Gymnasium Building, the Commons, the various Dormitories, the many sectional meeting rooms, the rooms for headquarters for our foreign guests, the offices for our officers and the rooms looking to the campus and

To the President and the Board of Trustees of the College of the City of New York, for the use of the Great Hall, and for the many courtesies of the President, John H. Finley, for the uniform good will shown to all the members on the occasion of this Congress.

Professor Samuel A. Baldwin, for the splendid renditions on the organ in the Great Hall of the College of the City of New York.

To Professor H. Fairfield Osborn, President, and the Board of Trustees, of The American Museum of Natural History, for the use of the Auditorium, and for their hospitality, in throwing open to the Members of the Congress, the entire Museum as well as for the splendid reception held in the Museum.

To J. Pierpont Morgan, President, and the Trustees, for their permission to use the Metropolitan Museum of Art, and extend to the Eighth International Congress of Applied Chemistry, the use of the entire Museum, the room of the Board of Trustees.

To the President, and the Officers and Members of the American Chemical Society, for their courtesy in arranging for the reception held at the Metropolitan Museum of Art, on the evening of September 7, 1912.

To the Broad Exchange Building Company for their kindness in presenting to the International Congress of Applied Chemistry the use of the large room at 25 Broad Street, as the home of the Committee, for practically two years, without charge.

To Thomas A. Edison and his co-workers for their hearty and arduous work in creating a successful phonographic device for the recording of discussions for the use of this Congress.

THE PRESIDENT: As many as are in favor, and we all feel indebted to those who have been named, and to a number of others who have not been named, because the hospitality and assistance of our friends in this city and in other cities has been simply beautiful—will signify by raising their hand. Contrary minded, no. It is a vote.

DR. DUISBERG: *Meine verehrten Damen und Herren:* Sie haben eben den Glanz des ganzen Kongresses vor Ihren Augen sich wieder entfalten sehen, und sind gewiss erstaunt gewesen, mit der Fuelle dessen, was uns hier geboten worden ist, aber der Kopf, der alles gemacht hat, ist noch nicht genannt worden. Als auf dem 7. Internationalen Kongress zu London beschlossen wurde, nach New York und Washington zu kommen, und Dr. Nichols der Praesident wurde, da sahen wir alle den Kopf, nicht den dicken Kopf, sondern den grossen Kopf. Wir wussten was wir, die wir ihn kannten, an ihm hatten, und alle, die ihn sahen, waren von vornherein durch seine liebenswuerdige Persoenlichkeit davon ueberzeugt, dass er die Sache grossartig durchfuehren wuerde. Wie hat er es nun gemacht? Er hat uns alle in Erstaunen gesetzt. Er fing ganz amerikanisch an;

fuhr nicht etwa mit dem Zug oder schrieb Briefe an die verschiedenen Staaten, sondern nahm sein Automobil und fuhr ueber den ganzen Kontinent damit und lud alle persoenlich ein, dieses Land zu besuchen, und durch seine Persoenlichkeit und seine Liebenswuerdigkeit bewies er Ihnen die Notwendigkeit nach Amerika, zu unserem Freunde, herzukommen, und sein Erfolg ist glaenzend gewesen. Besonders die Deutschen sind in grosser Zahl gekommen und das verdanken wir Herrn Nichols grosser Persoenlichkeit. Wir sind gekommen und koennen unserem Erstaunen nicht Ausdruck geben ueber die ganze Organization. Er hat unendlich viel selbst geleistet. Ich weiss aus geheimer Quelle dass er das alles selbst gemacht hat, unterstuetzt wohl von den hochwuerdigen Maennern, die er um sich hat, aber er ist derjenige gewesen, der alles organisiert und gemacht hat. Wie hat er uns behandelt, mit seinem liebenswuerdigen Herzen, mit seiner grossartigen Jovialitaet und seiner freundlichen Art und Weise, und was hat er da alles ueberstanden. Jetzt faengt die Stimme an etwas schwach zu werden. Der Magen ist aber ganz unveraendert, oblgeich wir alle anfangen, etwas Hunger zu zu spueren. Selbst in diesem Lande gilt doch der wohl bekannte Goethesche Spruch und diesem Mann, und seiner liebenswuerdigen Frau Gemahlin, ohne die er sicherlich nie in der Hoehe geblieben waere, in der er ist, wollen wir unsere Hochachtung and Liebe beweisen, in dem wir uns alle von unseren Sitzen erheben.

THE PRESIDENT: A little matter of business which I have overlooked, and which I consider of considerable importance. The Executive Committee of this Congress had to follow a precedent in the formation of sections and sub-sections, and it is very difficult to do this, and very often a section numbered VIII is numbered a, b, c, and d, and it is very difficult to follow, and so the International Commission took that matter up the other night, and it is the unanimous opinion of the Commission that future Congresses should limit the sections to the smallest number possible or convenient; that there should be no sub-sections; that the sections should be numbered consecutively, and that the discretion as to the number of sections shall reside with the Executive Committee of the respective Congresses. That is

very simple. It explains itself, but I would like to ask Mr. Mailloux to put that in French.

(Mr. Mailloux repeats the motion in French.)

THE PRESIDENT: That is so simple, that I am sure you don't want any discussion. As many as are in favor of that resolution, which will apply to all future Congresses, will signify by raising the hand. Contrary, no. That is a vote.

As far as I am aware, the business of this Congress, all recommendations of the International Commission, are finished. I think we have nothing else, have we? If the business is finished —last night at the banquet we had the felicitations of very, very many of our friends from all parts of the world. It is hoped that today we will not have many felicitations, but there are one or two whom I have promised might have a word. You must remember we had it all last night. You know how we feel. We want to relieve them of the necessity of saying it, but there are some of our friends from Japan, and one of our friends from Belgium, and from Portugal who want to speak. There are one or two cases, or possibly three; otherwise I think the American Committee would be very thankful to be relieved from too many further felicitations, and first I will call on Mr. Aulard.

M. AUGUSTE AULARD: *Monsieur le Président, Mesdames et Messieurs:* L'un des membres organisateurs du premier Congrès International de chimie appliquée avec son instigateur M. François Saxe, de Bruxelles (premier Congrès qui se tient en Belgique en Août 1894) délégué par le Gouvernement belge pour être l'un de ses représentants au VIIIème Congrès de Washington-New York, ce n'est pas sans une certaine fierté que je revendique pour mon petit pays si versé dans les arts, les sciences et l'industrie, la grande part qui lui revient dans la création des Congrès internationaux de chimie appliquée.

Je me crois autorisé à faire la comparaison entre les divers Congrès étant, je pense, le seul ayant participé et collaboré par mes travaux à tous ceux qui se sont tenus depuis leur institution à Bruxelles, Mars 1894, Paris, Vienne, Paris (1900) Berlin, Rome, Londres, New York.

Sans flatterie, laissez-moi vous dire, Monsieur le Président Nichols, à vous, au secrétaire général Monsieur Bernhard

Hesse et à notre aimable collègue Matheson secondé par les membres éminents de notre Comité exécutif, que le Congrès des Etats-Unis a réussi plus brillamment encore que ses devanciers—ce qui n'est pas peu dire—.

Vous avez su agrémenter nos travaux, parfois pénibles, par la chaleur accablante qui régnait, de réjouissances fastueuses nous faisant apprécier les beautés naturelles, artistiques et industrielles de votre grandiose et étonnant pays; de ce New York nouvelle Babylone, majestueux, même en ses "gratte ciel," comme nous appelons en Europe, vos caravansérails modernes, de ce New York orgie et régal des yeux de par sa fée électricité.

A côté de vos musées qui renferment des merveilles artistiques qui m'ont autant charmé à Chicago qu'à New York, musées qui prouvent la puissance intelligente de vos mécènes millionnaires heureusement souvent généreux.

J'ai été frappé de ne point voir déambuler de par vos rues les innombrables militaires disséminés, ennuyés que nous rencontrons dans nos vieux pays qualifiés vieille civilation.

Vous, mes Chers Collègues des Etats-Unis, vous avez confiance et foi en votre force américaine faite d'individualisme uni à l'heure du danger. Vous n'êtes pas sans Patrie, parce que vous n'avez que vos frontieres protegies d'une armée possible à l'heure critique: vous préférez laisser travailler vos soldats au développement industriel de votre puissant pays.

Permettez-moi, Monsieur le Président, de pousser un "hourra" en l'honneur de votre République si sage et si fertile en étoiles sans cesse de plus en plus nombreuses et si pour terminer, nous vous remercions de toutes vos attentions pour tous. Je puis émettre un voeu humanitaire moi citoyen d'un pays neutre, permettez-moi, en mon nom personnel et qui sait, peut-être au nom de toutes les mères de mon petit et glorieux pays, de formuler le voeu de voir l'Europe nous donner un jour prochain une vue également étoilée comprenant après des siècles de guerre que la paix armée qui enlève aux nations des millions de francs qui pourraient être mieux employés qu'à manier les outils de servitude et de mort.

A vous, Messieurs les américains qui êtes d'existence européenne française, allemande, anglaise, italienne, espagnole, voir même belge et hollandais, à vous, Président Nichols, qui avez su être bienveillant et grand parmi les plus grands de vos Etats-Unis, je vousdis encore: Merci.

M. Ferreira de Silva: *Monsieur le Président, Mesdames, Messieurs:* Lorsque le Portugal fût invité à se faire représenter dans le VIIIème Congrès International de chimie appliquée qui devait se réunir dans ce nouveau monde, l'invitation a été accueillie avec le plus vif intérêt.

La preuve est que, pour la première fois, deux représentants officiels de mon pays se sont trouvés dans un Congrès de chimie appliquée. Ce sont:

Mon collègue et ami, M. Ch. Lepierre (qui venait de la part du Ministère de l'Intérieur et de l'Institut Technique de Lisbonne); moi-même, (j'etais le délégué de l'Académie Polytechnique de Porto—aujourd'hui Faculté des Sciences—et de la Société chimique portugaise, la plus jeune des Sociétés chimiques actuelles).

Eh bien, Monsieur le Président, Mesdames et Messieurs, je vous affirme que, après les embarras des premiers moments, notre expectative a été dépassée.

Il nous reste de vous un souvenir affectueux et le respect pour vos progrès, car vous n'êtes seulement que les conquérants glorieux et indépendants de cette classique de liberté. Vous nous avez montré les raffinements d'une courtoisie simple et noble dans l'accueil affable que vous nous avez fait. Nous vous faisons nos adieux en vous connaissant mieux et en vous aimant plus.

Au nom de mon Gouvernement, en l'absence forcée de mon collègue, je vous remercie encore, Monsieur le Président, M. le Secrétaire Général et le Comité organisateur du Congrès, de toutes vos amabilité et de votre bon accueil. J'ai aussi le devoir de présenter mes sincères hommages à l'honorable Président du Chemists' Club, Monsieur le Docteur Loeb. Nous garderons de ce trop court séjour parmi vous un doux souvenir. "Puissent ces réunions triennales établir non-seulement entre les savants, mais entre les citoyens de tous les pays civilisés cet état de paix indispensable à nos travaux, cette fraternité sainte, sans laquelle

la civilation et le progrès ne seraient bientôt plus que des vains mots." Ce sont les parloes de M. le Prof. Armand Gautier, mon ami, dans la clôture du Congrès de Londres: ce sont aussi mes voeux.

THE PRESIDENT: I see a friend from Japan sitting here, and I know he wants to say a word, for the reason I gave, that he could not speak last night.

DR. T. NISHIKAWA: *Mr. President, Ladies and Gentlemen:* I have the honor to address a few words on behalf of the representatives of Japan. We beg to tender our grateful thanks for all the kindness and consideration shown towards us, not only by the President and officers of this Congress, but by the people of this country. It has occurred to me that, some sixty years ago, your Commodore Perry came to us and knocked upon our door, that somewhat forcibly, and told us that we must awake from our slumber and join the "comity of nations." So you have kindly invited us here and shown us how, with consummate skill and good feeling, work and pleasure can be combined. You have given us a splendid object lesson, and we hope at some future time we shall be able to invite you all to Japan to the old city of Tokyo, and try to show you that we have benefited by this lesson. So you will return home with the idea that the little people in the little Islands are delighted to give pleasure to their visitors. We thank you very much for your kindness.

THE PRESIDENT: And he means every word of it, and so do his friends and colleagues who came with him.

Is there anything further to bring before the Congress? If not, I declare the Eighth International Congress of Applied Chemistry, closed. I beg to thank all the members for their attendance, and all of our confrères and colleagues for their assistance, and I bespeak for my good friend, Mr. Walden, who now is the president of the Ninth Congress, and who is now in one moment to be in the saddle—I bespeak for him the same cordial coöperation you have given so liberally to me.

(The Congress closed amid applause at 1.20 p. m.)

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OF THE
EIGHTH INTERNATIONAL CONGRESS
OF
APPLIED CHEMISTRY

Washington and New York
September 4 to 13, 1912.

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Die Beschaffung geeigneter Vorträge.
Ausarbeitung von Berichten.
Stellung von Anträgen und
Werbung von Teilnehmern ihrer Sektion an dem Kongress.

Der jeweils erstgenannte Verein hat die Leitung der Arbeiten für die betreffende Abteilung und übermittel talle Vorschläge an die Leipziger Zentralstelle zurweiteren Behandlung:

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Verband selbständiger öffentlicher Chemiker Deutschlands.

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Deutsche Bunsen-Gesellschaft für angewandte physikalische Chemie.

Abteilung 2b

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Fachgruppe für Kaliindustrie des Vereins deutscher Chemiker.

Abteilung 3a

Metallurgie und Hüttenkunde

Verein deutscher Eisenhüttenleute.
Geheimrat Prof. Mathesius.

ABTEILUNG 3B

Explosivstoffe

Zentralstelle für wissenschaftlich-technische Untersuchungen, Neubabelberg.

ABTEILUNG 3C

Silicatindustrien

Deutscher Verein für Ton-, Zement- und Kalkindustrie E. V.
Verein deutscher Portlandzementfabrikanten E. V.

ABTEILUNG 4A

Organische Chemie

Deutsche Chemische Gesellschaft.
Fachgruppe für organische Chemie und Halbfabrikate des Vereins deutscher Chemiker.
Physikalischer Verein zu Frankfurt a. M.

ABTEILUNG 4B

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Verein der deutschen Textil-Veredelungsindustrie.

ABTEILUNG 5A

Zuckerindustrie

Verein der Deutschen Zucker-Industrie.

ABTEILUNG 5B

Kautschuk und Industrien plastischer Stoffe

Verein deutscher Chemiker.
Kolonial-Wirtschaftliches Komittee.

ABTEILUNG 5C

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Deutscher Braunkohlen-Industrie-Verein (Verband der Braunkohlen-Industriellen Deutschlands) E. V.
Verein für Mineralölindustrie.
Verein für die bergbaulichen Interessen im Oberbergamtsberzirk Dortmund.

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Fette, Oele und Seifen

Fachgruppe für Mineralöl und verwandte Fächer des Vereins deutscher Chemiker.

Abteilung 5e

Farben, trocknende Oele und Firnisse

Verein deutscher Chemiker.

Abteilung 6a

Zellstoff und Papier

Verein der Zellstoff- und Papierchemiker.
Verein deutscher Zellstoff- Fabrikanten.

Abteilung 6b

Starkeindustrie und Gärungsgewerbe (wissenschaftl. Untergruppe)

Die im Institut für Gärungsgewerbe vereinigten Verbände.
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Verband der Brauerei- und Mälzereichemiker.
Deutscher Brauer-Bund.
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Abteilung 6c

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Abteilung 7a

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ABTEILUNG 10B

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United States Brewers' Association.
United States Maltsters' Association.

Wing and Evans.
A. E. Warner.
Warner Sugar Refining Company.
West Virginia Pulp and Paper Company.
Western Electric Company of New York.
Edward Weston.
R. S. Weston.
W. A. and A. M. White.
George Wiedemann Brewing Company.
Wood Products Company.

WORK OF THE CONGRESS

The work of the Congress in New York was accomplished in 118 sectional meetings, 28 joint sessional meetings, four General Lectures, and the Final General Meeting, or a total of 151 meetings.

In addition to this there were opportunities for factory and similar inspection, and numerous social functions; of the latter only those tendered to the Congress as a whole, or to designated parts thereof, are recorded in the following:

FACTORY INSPECTION IN AND ABOUT NEW YORK CITY

The following factories and works were inspected by members of the Congress:

American Smelting and Refining Company, Maurer, N. J.
American Sugar Refining Company, Jersey City.
Botany Worsted Mills, Passaic, N. J.
Bush Terminal Company, Brooklyn.
Consolidated Gas Company, Astoria.
Corn Products Refining Company, Edgewater, N. J.
F. W. Devoe and C. T. Raynolds Company, Brooklyn.
The Fleischmann Company, Peekskill.
General Chemical Company, Edgewater, N. J.
John W. Masury and Sons, Brooklyn.
Nichols Copper Company, Laurel Hill.
G. Siegle Company, Rosebank.
Standard Oil Company, Queens County Works.

THE SOCIAL FUNCTIONS IN NEW YORK CITY

Reception to members of the Congress speaking the Latin tongues by Professor and Mrs. Morris Loeb at the Chemists' Club, September 2.

Reception and tea by the trustees of the American Museum of Natural History at the Museum, September 7.

Reception to all members of the Congress at the Metropolitan Museum of Art by the American Chemical Society, September 7.

Boat excursion on the Hudson, September 8.

Reception to all members of the Congress by the Chemists' Club at its clubhouse, September 10.

Entertainment at the New York Hippodrome, September 11.

Grand Banquet, September 12.

Baseball game at the Polo Grounds, September 13.

An informal reception and tea was given in the afternoons of September

6, 9, 10 and 11 on the lawn of the College of the City of New York, and on September 12 on the lawn at Columbia University.

In addition to the above, the program for the ladies provided for an informal reception and welcoming meeting on the lawn at Columbia University in the forenoon of September 6, and a lecture in Rumford Hall of the Chemists' Club on "Communal Work of Woman in America" in the afternoon; automobile sightseeing trips and luncheon at the Claremont on September 9; automobile sightseeing trips and visit to the store of Gimbel Brothers on September 10; automobile sightseeing trips and a concert in Rumford Hall, Chemists' Club, on September 11, and a boat excursion about New York Harbor in the forenoon of September 12.

THE EXCURSIONS AND TRIPS

On Monday, September 16, the private excursion trains left New York on the long and short trip, respectively. Both trains proceeded to Philadelphia, Pittsburgh, Niagara Falls, Detroit and Chicago; from Chicago the short trip train returned East by way of Cleveland and Boston, where the party disbanded September 25. The long trip train proceeded from Chicago to Denver, Colorado Springs, Glenwood Springs, Salt Lake City, Bakersfield, San Francisco, Oakland, Berkeley, Richmond, Stanford University, Los Angeles, Riverside, Grand Canyon, Adamana, Albuquerque, El Paso, Pecos City, Fort Worth, Shreveport, New Orleans, Birmingham, Atlanta, Ducktown, Canton, Waynesville, Asheville, Charlotte, Great Falls, Danville, Washington to New York, where it disbanded October 20. The total number of cities so visited was 37.

Members of the Congress visited the following plants, institutions and places:

AT PHILADELPHIA
- Atlantic Refining Company.
- Baldwin Locomotive Works.
- Joseph Campbell Company.
- The William Cramp Ship and Engine Building Company.
- Harrison Brothers and Company, Inc.
- Independence Hall.
- The Krebs Pigment and Chemical Company.
- Municipal Filtration Works.
- The J. B. Stetson Hat Company.
- United Gas Improvement Company.
- United States Mint.
- University of Pennsylvania.

AT PITTSBURGH
- Allegheny Coal Company.
- Allegheny Plate Glass Company.
- Atlantic Refining Company.
- Carnegie Institute of Technology.

Carnegie Steel Company, Clairton Works.
Crucible Steel Company of America.
General Chemical Company, Newell Works.
A. Guckenheimer and Brothers.
Harbison-Walker Refractories Company.
H. J. Heinz Company.
National Tube Company.
Pennsylvania Smelting Company.
Philadelphia Company.
Pittsburgh and Lake Erie Railroad.
Pittsburgh Filtration Works.
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Pittsburgh Steel Company.
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United Engineering and Foundry Company.
United States Bureau of Mines, Testing Station.
United States Bureau of Standards, Testing Station.
United States Glass Company.
University of Pittsburgh.
Ward-Mackey Company.
Westinghouse Electric and Manufacturing Company.
Westinghouse Machine Company.

AT NIAGARA FALLS

International Acheson Graphite Company.
Niagara Alkali Company.
Niagara Chocolate Company.
Niagara Falls Power Company.
Ontario Power Company.
Shredded Wheat Company.
Trip on the Gorge Route with the compliments of Mr. E. G. Acheson.

AT BUFFALO

Contact Process Company.
Larkin Company.
Pierce-Arrow Motor Car Company.

AT DETROIT

Acme White Lead and Color Works.
Aluminum Casting Company.
American Blower Company.
American Electric Heater Company.
Berry Brothers.
Burroughs Adding Machine Company.
Cadillac Motor Car Company.
Chalmers Motor Car Company.
Detroit Creamery Company.

Detroit Sulphite Pulp and Paper Company.
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Ford Automobile Company.
Hiram Walker and Sons, Walkerville, Ont.
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Hudson Automobile Company.
Michigan Malleable Iron Works.
Michigan Stove Works.
Packard Motor Car Company.
Parke, Davis and Company.
Solvay Process Company.
Studebaker Corporation.
Timken-Detroit Axle Company.
University of Michigan.
Williams Brothers Preserving Company.

AT CHICAGO

Abbott Alkaloidal Company.
Armour Institute of Technology.
Armour and Company, Union Stock Yards.
Art Institute.
Brewers' and Distillers' Laboratory.
Chas. C. Kawin Company's Laboratory.
Chicago Public Library.
Commonwealth Edison Company.
Corn Products Refining Company, Argo, Ill.
Dearborn Drug and Chemical Works Laboratory.
Heath and Milligan Manufacturing Company.
Hull House.
Illinois State Food Commission Laboratory.
Illinois Steel Company; plants visited at Gary, Indiana, and South Chicago, Ill.
International Harvester Company.
John Crerar Library.
Morris and Company, Union Stock Yards.
National Lead Company.
Sears, Roebuck and Company.
Thirty-ninth Street Sewage Testing Station.
Sprague, Warner and Company.
Swift and Company, Union Stock Yards.
Universal Portland Cement Company's plant at Buffington, Indiana.
United States Food and Drug Laboratory.
Wahl-Henius Institute.
William Hoskins.
Morris S. Schwartz.

In the neighborhood of Chicago:
- LA SALLE, ILLINOIS
  - German-American Portland Cement Company.
  - La Salle Coal and Carbon Company.
  - Matthiessen, Hegler Zinc Company.
  - Guests were entertained in La Salle by the La Salle Commercial Association.
  - Mr. Matthiessen also entertained at his home in Deer Park.
- PERU, ILLINOIS
  - Illinois Zinc Company.
- MILWAUKEE, WISCONSIN
  - Pabst Brewing Company.
  - Pfister and Vogel Leather Company.

AT CLEVELAND
- Cleveland Salt Company,
- National Electric Lamp Company
- Pennsylvania Railroad Company's overloading plant.

AT SCHENECTADY
- The General Electric Company.

AT ALBANY
- The Hudson River Aniline Color Works.

IN BOSTON AND VICINITY
- Amoskeag Manufacturing Company at Manchester, N. H.
- Arlington Mills, Lawrence, Mass.
- Boston Woven Hose and Rubber Company.
- Consolidated Gas Company.
- Fore River Shipbuilding Company, Quincy, Mass.
- General Electric Company, Lynn, Mass.
- Gloucester Fisheries, Gloucester, Mass.
- A. D. Little and Company, Lynn, Mass.
- Lowell Textile School, Lowell, Mass.
- National Calfskin Shoe Company, Peabody, Mass.
- New England Gas and Coke Company, Everett, Mass.
- Pacific Mills, Lawrence, Mass.
- The Thomas G. Plant Company.
- Sorosis Shoe Company.
- Wood Worsted Mills, Lawrence, Mass.
- Complimentary Dinner by the Chemists of Boston.
- Complimentary Luncheon to the ladies at the Brookline Country Club.

AT DENVER
- American Smelting and Refining Company.
- Denver Fire Clay Company.
- Western Chemical Company.
- Henry Woods Ore Testing Company.

AT SALT LAKE CITY

- Sight seeing trip through Salt Lake City.
- Organ Recital on the Great Organ of the Mormon Tabernacle.
- Trip to Great Salt Lake.
- Complimentary Dinner at the Commercial Club.

AT BAKERSFIELD, FELLOWS AND TAFT.

- Panorama Heights.
- Fruit Canneries and raisin driers.
- Kern River Oil Fields.
- Lake View Gusher.
- Inspection of the Midway oil fields.
- Standard Oil Company and complimentary luncheon.
- Honolulu Oil Company.
- Union Oil Company.

AT SAN FRANCISCO AND ENVIRONS

- University of California; complimentary reception and luncheon.
- du Pont de Nemours explosive plant at Pinole.
- Standard Oil Company.
- Selby Smelting and Lead Works at Selby.
- California Wine Association at Wine Haven.
- Panama Pacific International Exposition Grounds.
- Muir Woods.
- Mt. Tamalpais.
- Pacific Gas and Electric Company.
- California Fruit Canners Association and complimentary supper.
- Ghirardelli's Cocoa and Chocolate Works.
- E. C. Whitney Company.
- Leland Stanford, Jr., University, complimentary reception.

AT FORT WORTH

- Armour and Company; complimentary luncheon.
- Elks Club.
- Fort Worth Cotton Oil Company.
- Fort Worth Elevators Company.
- Fort Worth National Bank.
- The Texas Brewing Company; complimentary luncheon.
- Trinity Compress Company.
- Westbrook Hotel.
- The Chamber of Commerce gave a theatre party at the Majestic theatre.

AT SHREVEPORT

- Cotton Oil Mills.
- Cotton Compresses.
- Automobile drive about the city.
- Dawes Burning Well at Oil City.
- Busch Everett oil wells at Caddo City.

McCue Gas well at Lewis.
Hanell Lease of Producers Oil Company at Viva.

At New Orleans
- Automobile drive about the city.
- Municipal Water Plant.
- Chalmette Sugar Refinery.
- Progressive Union; complimentary luncheon.

At Atlanta
- Automobile ride about the city.
- Armour and Company's Fertilizer Plant.
- Complimentary Luncheon, Piedmont Driving Club.
- Illustrated Lecture, S. W. McCallie, State Geologist.
- Reception by Honorable Joe Brown, Governor of Georgia.
- Complimentary Dinner, Capital City Club.

At Ducktown
- Tennessee Copper Company; smelting plant and their Burra-Burra Mines.

At Charlotte
- Highland Park Manufacturing Company.
- Southern Cotton Oil Company.

At Great Falls
- Southern Power Company's hydroelectric plant at Great Falls; complimentary luncheon.
- Southern Electrochemical Company's Electrochemical plant at Nitrolee.

THE LOCAL COMMITTEES

In most, if not all, the cities in which the Congress visited local committees were formed, or the arrangements for the comfort of members of the Congress were under the care of organizations. The persons and organizations to whom members of the Congress are indebted for their reception in these cities is as follows, arranged in the order in which the cities were visited:

WASHINGTON AND BALTIMORE COMMITTEE OF ARRANGEMENTS

Honorary Chairman, Dr. Harvey W. Wiley.

S. F. Acree.
A. B. Adams.
L. H. Adams.
E. T. Allen.
C. L. Alsberg.
H. S. Bailey.
M. Benjamin.
W. N. Berg.
W. D. Bigelow.
W. Blum.
E. W. Boughton.
A. H. Bryan.
H. H. Bunzell.
E. A. Byrnes.
J. R. Cain.
F. K. Cameron.
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V. K. Chestnut.
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A. E. Hill.
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J. C. Hostetter.
C. E. Waters.
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R. C. Wells.
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Reid Hunt.
H. A. Huston.
H. C. Jones.
L. F. Kebler.
C. F. Langworthy.
J. A. LeClerc.
A. S. McDaniel.
H. B. McDonnell.
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A. J. Marsh.
L. W. Mattern.
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H. N. Morse.
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W. B. D. Penniman.
I. K. Phelps.
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Ira Remsen.
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C. A. Rouiller.
C. F. Sammit.
H. Schreiber.
O. Schreiner.
A. Seidell.
E. S. Shepherd.
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M. X. Sullivan.
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F. P. Veitch.
S. S. Voorhees.
P. H. Walker.
M. I. Wilbert.
P. A. Yoder.
D. T. Day, *Secretary*.

PHILADELPHIA

His Honor, Mayor Rudolph Blankenburg.
M. L. Cooke, Director of the Department of Public Works.

Charles B. Adamson.
Gellert Alleman.
Theodore Armstrong.
G. E. Barton.
Daniel Baugh.
Gustave W. Bergner.
Samuel T. Bodine.
C. S. Brinton.
Miers Busch.
Milton Campbell.
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J. H. Carstairs.
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Arthur Dorrance.
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Howard B. French.
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O. L. Shinn.
Edgar F. Smith.
Walter M. Stein.
D. K. Tuttle.
Maxwell Wyeth.
C. E. Vanderkleed.
James G. Vail.

Executive Committee

W. H. Bower.
George C. Davis.
J. T. Dorrance.
Irenee DuPont.
James Gillinder, Jr.
C. Mahlon Kline.
Harlan S. Miner.
R. B. Owens.
Robert S. Perry.
George D. Rosengarten.
S. S. Sadtler.
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PITTSBURGH

Executive

James M. Camp, *Chairman.*
James O. Handy.
K. F. Stahl.
J. S. Unger.
Elmer K. Hiles, *Secretary.*

Finance

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Willis L. King.
H. W. Croft.
H. J. Heinz.
E. M. Herr.
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Elmer K. Hiles, *Secretary.*

Program

James O. Handy, *Chairman.*
R. K. Duncan.
F. C. Phillips.
Horace C. Porter.
H. E. Walters.

Entertainment

Karl F. Stahl, *Chairman.*
J. K. Clement.
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G. D. Chamberlain.
J. C. W. Greth.

Printing and Publicity

Elmer K. Hiles, *Chairman.*
Harrison W. Craver.
Horace C. Porter.

Ladies' Committee

Executive

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Mrs. James O. Handy, *Chairman.*
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Mrs. G. D. Chamberlain.
Mrs. H. C. Porter.
Mrs. F. C. Phillips.
Mrs. J. K. Clement.

Reception

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Mrs. D. M. Buck.
Mrs. G. H. Clapp.
Mrs. Fred Crabtree.
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A. B. Conner.
J. M. Francis.
H. C. Hamilton.
R. T. Harris.
L. B. Hayward.
Niels C. Ortved.
R. W. Perry.
W. P. Putnam.
Floyd W. Robison.
F. T. F. Stephenson.
Carl Sundstrom.
L. D. Vorce.

CHICAGO

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Mrs. Wm. Brady, *Chairman Ladies' Committee.*

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Mr. and Mrs. J. H. Birdsong.
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Mr. and Mrs. E. B. Bragg.
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Mr. and Mrs. L. A. Touzalin
Mr. and Mrs. D. H. Trowbridge.
Mr. and Mrs. J. A. Wesener.
Mr. and Mrs. W. B. Wiley.

BOSTON

LOCAL COMMITTEE

C. L. Gagnebin, 142 Oliver St., Boston.
Alan A. Claflin, 88 Broad St., Boston.
W. K. Lewis, Mass. Inst. Technology, Boston.
S. W. Wilder, 33 Broad St., Boston.
F. E. Gallagher, 93 Broad St., Boston.

LADIES' COMMITTEE

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Mrs. Alan A. Claflin, West Medford, Mass.
Mrs. Henry Howard, Brookline, Mass.
Mrs. Henry P. Talbot, West Newton, Mass.
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DENVER

ENTERTAINMENT COMMITTEE

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John Eckley.
W. D. Engle.
Herman Fleck.
Wm. Kittredge.
F. W. Traphagan.

COLORADO SPRINGS AND CRIPPLE CREEK

Philip Argal, Jr.
W. H. Cundy.
F. P. Walter.

SALT LAKE CITY

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G. H. Dern.
W. Clarence Ebaugh.
F. J. Pack.
J. E. Talmage.
Edw. R. Zalinski.

BAKERSFIELD

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H. A. Blodgett.
T. F. Burke.
F. H. Hall.
E. L. Hayes.
W. W. Kelly.
Leo G. Pauly.
J. C. Payne.
E. H. Roberts.

SAN FRANCISCO AND ENVIRONS

H. C. Capwell.
E. H. Dennison.
Bryant S. Drake.
Ralph A. Gould.
Frank Green.
Arthur Lachman.
Felix Lengfeld.
Edmond O'Neill.
O. W. Owen.
F. H. Schmidt.
Arthur Vogelsang.
San Francisco Board of Trade.
San Francisco Chamber of Commerce.

LOS ANGELES

Adolphus Busch
Los Angeles Chamber of Commerce.

FORT WORTH

Guy Eldridge.
H. E. Finney.
G. M. Holbrook.
Ed. Laskar.
W. C. Moore.
R. H. Needham.
F. B. Porter.
W. G. Turner.
Jach Werden.
Werner Wilkins.

SHREVEPORT, LA.

ENTERTAINMENT COMMITTEE

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C. P. Clayton.
A. G. Curtis.
S. W. Devore.
George Gilmer.
W. E. Glassell.
S. N. Guy.
S. B. Hicks.
S. S. Hunter.
C. D. Keen.
E. F. Kuehnle.
S. W. Mason.
E. C. MCCOLGIN, *Secretary Chamber of Commerce.*
Joe McCue.
E. R. Ratcliff.
E. K. Smith.

NEW ORLEANS

Progressive Union, WM. B. M. TREZEVANT, *Secretary,*
New Orleans Section of the American Chemical Society.
Professor C. E. Coates, Louisiana State University.

BIRMINGHAM

Chamber of Commerce.
Professor B. B. Ross, Alabama Polytechnic Institute.

ATLANTA

Atlanta Chamber of Commerce.
Georgia Section of the American Chemical Society.

DUCKTOWN

Ducktown Copper Company.
Tennessee Copper Company.

A. J. Bone.
M. H. Caine.
T. W. Cavers.
D. F. Dryden.
A. N. Fairlie.
W. T. Foster.
Utley Wedge.
H. F. Wierum.

CANTON.

Champion Paper Company.

WAYNESVILLE

Chamber of Commerce.

ASHEVILLE

Lucien Buck.
Reuben B. Robertson.
N. Buckner.
George Trostel.

CHARLOTTE

Leake Caraway.
Charles C. Hooke.
James A. Houston.
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GREAT FALLS.

Charles I. Burkholder.
William S. Lee.
Frank L. Moser.
Richard Pfaehler.
Frederick D. Sampson.
Harry A. Tibbs.

The donors to the funds required for the entertainment of the visiting members of the Congress in the various cities were as follows:

WASHINGTON

W. D. Bigelow, for Bureau of Chemistry.
Byrnes, Townsend & Brickenstein.
F. K. Cameron, for Bureau of Soils and Department of Agriculture.
T. M. Chatard.
C. A. Crampton, for Institute of Industrial Research and U. S. Patent Office.
A. S. Cushman.
David T. Day.
J. D. Davis, for Bureau of Mines.
F. P. Dewey, for Treasury Department.
John T. Devine, for Shoreham Hotel.
Peter Fireman.
Duane E. Fox.
T. T. Gaff.
Reid Hunt, for Bureau of Hygiene.
Charles E. Munroe.
New Willard Hotel.
Chase Palmer, for U. S. Geological Survey.
T. G. Palmer.
W. F. Roberts and Company.
S. S. Voorhees, for Bureau of Standards.
Harvey W. Wiley.
T. A. Witherspoon.

PHILADELPHIA

Ajax Metal Company.
Atlantic Refining Company.
Joseph Bancroft and Sons Company.
J. Bishop and Company Platinum Works.
E. E. Brown and Company.
Miers Busch.

Henry Bower Chemical Manufacturing Company.
Cambria Steel Company.
Joseph Campbell Company.
H. M. Chance.
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Charles Gibbons Davis.
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Link Belt Company.
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PITTSBURGH

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American Vanadium Company.
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National Lead and Oil Company.
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CHICAGO

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American Bridge Company.
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American Refractories Company.
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Armour and Company.
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Chicago Association of Commerce.
Chicago and Northwestern Railway.
Chicago Portland Cement Company.
Chicago Varnish Company.
City Fuel Company.
Coca Cola Company.
Columbus Laboratories.
Commonwealth Edison Company.
Continental and Commercial National Bank.
Continental Can Company.
Corn Exchange National Bank.
Crane and Company.
Dearborn Drug and Chemical Works.
Deere and Company, Moline, Ill.
J. K. Dering, Coal Company.
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Drovers Deposit National Bank.
Edgar Allen Magnanese Steel Company.
N. K. Fairbank Company.
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First National Bank.
Fleischmann Yeast Company.
Fort Dearborn National Bank.
General Chemical Company.
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Grand Crossing Tack Company.
Great Western Smelting and Refining Company.
Harbison-Walker Refractories Company.
A. W. Harris, Vice-President Harris Trust and Savings Bank.
Heath and Milligan Manufacturing Company.
Hibernian Banking Association.
Hoover and Mason.
Hotel Sherman.
R. W. Hunt and Company.
Illinois Steel Company.

Illinois Zinc Company, Peru, Ill.
Industrial Appliance Company.
Inland Steel Company.
International Harvester Company.
Iroquois Iron Company.
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Jas. S. Kirk Company.
H. Koppers Company.
Link Belt Company.
Live Stock Exchange National Bank.
Franklin MacVeagh and Company.
Manganese Steel Rail Company.
Marden, Orth and Hastings.
Matthiesson, Hegler Zinc Company, La Salle, Ill.
Merchants Loan and Trust Company.
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Morris and Company.
Mumm Champagne and Importation Company.
J. B. Murphy, Sheboygan, Wis.
National Bank of the Republic.
National Lead Company.
Northern Trust Company.
Pickands, Brown and Company.
James H. Pierce.
Pfister Vogel Leather Company, Milwaukee, Wis.
Quaker Oats Company.
Reid Murdock and Company.
E. H. Sargent and Company.
Sears, Roebuck and Company.
South Chicago Savings Bank.
Sprague, Warner and Company.
Standard Trust and Savings Bank.
Chas. G. Stevens Company.
Sultzberger and Sons Company.
B. E. Sunny.
Swenson Evaporator Company.
Swift and Company.
Thorkildsen-Mather Company.
Union Trust Company.
Universal Portland Cement Company.
Vilter Manufacturing Company, Milwaukee, Wis.
Vulcan-Louisville Smelting Company.
Western Clock Company, La Salle, Ill.
Wisconsin Steel Company.

BOSTON

American Agricultural Chemical Company.
Badische Company.
Berlin Aniline Works.
Godfrey Cabot.
The Carter's Ink Company.
Chas. A. Catlin.
Champion International Company.
Alan A. Claflin.
Cochrane Chemical Company.
Crane and Company.
Farbenfabriken of Elberfeld Company.
Fort Hill Chemical Company.
C. L. Gagnebin.
Geigy-ter Meer Company.
Kalle and Company.
Arthur D. Little, Inc.
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H. A. Metz and Company.
Geo. H. Morrill Company.
Mount Tom Sulphite Pulp Company.
National Aniline and Chemical Company.
Revere Rubber Company.
Simplex Electrical Company.
Stone and Webster.
Elihu Thomson.
United States Rubber Company.
R. S. Weston.

DENVER

The Chamber of Commerce.
The Coors Brewery Company.
Denver Fire Clay Company.
W. D. Engle.
The Mines and Smelter Supply Company.
F. W. Traphagan.
The Western Chemical Company.

SALT LAKE CITY

"Convention Fund" of Salt Lake City.

BAKERSFIELD

Chamber of Commerce.

SAN FRANCISCO

San Francisco Chamber of Commerce.
San Francisco Board of Trade.

OAKLAND

Oakland Chamber of Commerce.

RICHMOND

Richmond Board of Trade.

LOS ANGELES

Los Angeles Chamber of Commerce.
Adolphus Busch.

FORT WORTH

Armour and Company.
Chamber of Commerce.
Fort Worth Cotton Oil Company.
Fort Worth Elevators Company.
Fort Worth National Bank.
Texas Brewing Company.
Trinity Compress Company.
Westbrook Hotel.

SHREVEPORT

Shreveport Chamber of Commerce.

NEW ORLEANS

Progressive Union.

ATLANTA

Armour Fertilizer Works.
Atlanta Chamber of Commerce.
J. S. Brogdon.
Georgia Railway and Electric Company.
B. M. Hood Brick Company.
International Agricultural Corporation.
A. M. Lloyd.
McCandless Laboratory.
Old Dominion Guano Company.
Picard Law Company.
Porter Fertilizer Company.
N. P. Pratt.
N. P. Pratt Laboratory.
Southern Cotton Oil Company.

CHARLOTTE

The Greater Charlotte Club.

MEMBERS

(Names preceded by * are the names of those who registered in New York.)

AFRICA

Boname, P., Reduit, Mauritius.

Gilly, H., Expert chimiste a Boufarik, Alger, Algeria.

Giraud, Pierre Leopold, Alma, Verdun, Mauritius.

Khouri, Joseph, 4 Rue de France, Alexandrie, Egypt.

Lucas, Alfred, Dr., Public Works, Ministry Gardens, Cairo, Egypt.

McCrae, John, Ph.D., F.I.C., Box 1080, Johannesburg, Transvaal, South Africa.

*Moir, James, Mines Department of South Africa, P. O. Box 1132, Johannesburg, South Africa.

Mosséri, Victor, M., 25 Rue Cheik Abou Seba, Cairo, Egypt.

Senergous, L., 48 Bd. Seguin, Oran (Algeria).

ARGENTINA

Achard, Dr. Leopold, San José 468, Buenos Aires.

Alvarez, Nazario, Museo de La Plata, Ciudad, Provincia de Buenos Aires.

Angli, Jeronimo, F.C.S., calle Boedo 331, Lomas de Zamora, Provincia de Buenos Aires.

Arata, Dr. José S., calle Rivadavia 2261, Buenos Aires.

Arata, Dr. Pablo C., calle Rivadavia 2261, Buenos Aires.

Arata, Pedro N., calle Rivadavia 2261, Buenos Aires.

Bado, Dr. Atilio, calle Bolivia 585, Buenos Aires.

Barraza, Dr. Francisco C., calle Cordoba 716, Buenos Aires.

Bernaola, Victor J., Mueso de La Plata, Ciudad, Provincia de Buenos Aires.

Blouin, R. E., Director Estacion Agricola, Tucuman.

Bolognini, Dr. Hector, calle Cochabamba 3114, Buenos Aires.

Botto, Alejandro, Museo de La Plata, Ciudad, Provincia de Buenos Aires.

Bragadín, José, Museo de La Plata, Ciudad, Provincia de Buenos Aires.

Calatroni, Ricardo, Museo de La Plata, Ciudad, Provincia de Buenos Aires.

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THE REPORT OF THE SECRETARY

The preparatory work for this meeting began June 11, 1910. Organization for practical work was fully effected in the United States by June, 1911. The 11 American committees then formed contained upwards of 900 American chemists (not allowing for duplications, which probably did not exceed 10 per cent.). The United States Government and the Governors of 49 States, Territories, Insular Possessions of the United States and the Commissioners of the District of Columbia, as well as 30 societies, were further included in these committees by specially appointed representatives, numbering 124 in all.

In March, 1911, the Government of the United States sent formal invitations to all the governments of the world to join in this Congress. Twenty-eight foreign governments accepted and sent a total of 107 delegates. In 18 countries separate organizing committees were formed or organizers were installed, containing upwards of 573 individuals (not allowing for duplications, which probably did not exceed 10 per cent.), and 55 societies and educational institutions.

The Executive Committee of this Congress especially invited 1,483 different technical, scientific and trade societies and educational institutions the world over to join the Congress. Two hundred and thirty-seven in 28 different countries accepted this invitation and appointed 1,348 delegates.

The total working force in the interests of this Congress the world over amounted therefore to not less than 2,000 individuals (not allowing for duplications, which probably did not exceed 10 per cent.), 392 societies and educational institutions, and 75 governments (including State governments of the United States).

On the publicity side the American Committee placed upon its mailing list 438 trade, technical and scientific publications the world over, and all were supplied with the various publications and appropriate news items from time to time. There were distributed by the Congress, and also on its behalf by American societies, such as the American Chemical Society, the American Electrochemical Society and the Chemists' Club, upwards of 300,000 pieces of printed matter describing the expectations, aims and hopes of this Congress, as well as its accomplishments to the then date, from about forty different points of view.

Communication was established with central organizing committees in Austria, Hungary, Belgium, Denmark, France, Germany, Great Britain, Greece, Japan, Netherlands, Dutch East Indies, Norway, Russia and Sweden and organizers were installed in Argentina, Chile, Italy and Portugal through and by whom publicity was maintained, as well as memberships solicited.

The American Sectional Presidents and their Sectional Executive Committees of the 24 different sections themselves by letter solicited papers from specialists the world over. Of these 24 only 17 sections kept a record of such outgoing matters, and these 17 sections sent out 17,176 letters for that purpose.

The net result of the work of this organization the world over is a total of 4,163 members residing in 36 different countries, of which 1,883 coming from 27 different countries, attended the Congress meeting and registered but more than 9% failed to bring their membership credentials with them although specifically requested so to do. Of these 1,883 members only 228 or 12% registered for sections; 1,284 papers were promised or submitted for the Congress; 304 of these were never supplied. Of the papers presented 20% were rejected either by the Sectional Committee or by the Committee on Papers and Publications, or by both committees. Of the 789 papers accepted by the Congress 560 or 71% were in print before the Congress assembled in New York. The remaining 229 papers appear in the Appendix. One thousand three hundred and twenty-two members withdrew their sets of the first 24 volumes of the original communications, and of these not fewer than 514 shipped them directly out of New York City leaving not to exceed 808 sets available for use in preparing discussions; no doubt only a very few of these 808 were used for any such purpose, which was the exact purpose for which so much additional labor and effort were expended.

Two hundred and seventy-seven ladies residing in 12 different countries acquired attendance cards, and of these 246 registered and attended the social functions of the Congress.

The work of the 24 sections was accomplished in 146 meetings

TABLE NO. 1.

Summary of the Work of the Congress (see p. 473).

	Number of meetings held	Attendance	Duration in minutes	Number of papers		Resolutions offered	Papers carried over	Left-over papers read at subsequent meetings	Papers read by			Exhibits and specimens	Lantern	Experiments	Number of participants in discussions	Time in minutes used in		Time in minutes used outside of reading and discussing papers
				Read	Discussed				Author	Author's representative	Title					Reading	Discussing	
Sectional Meetings .	118	3,956	10,127	546	252	24	147	81	286	129	131	38	8	3	610	4,597	2,987	2,543 (25%)
Joint Meetings	28	5,747	2,873	157	80	1	25	5	96	23	38	17	13	4	250	1,603	929	341 (11%)
Grand Total	146	9,703	13,000	703*	332	25**	172†	86	382	152	169	55	21	7	860	6,200	3,916	2,884 (22%)

* 86 papers, or 11 % of the total, were not in any way presented to the Congress and were therefore of no interest whatever to it.

† 172 papers, or 22 % of the total, were carried over from the assigned program because of the absence of the author or his representative.

** Of these 25 resolutions 9 were laid before the Congress by the Commission of International Congresses of Applied Chemistry; the remaining 16 failed to be so brought up for final action because of the failure of their sponsors to attend to the necessary details required by the constitution and by-laws of the Congress.

(118 sectional meetings and 28 joint meetings), various details in connection with which are given in table No. 1.

It appears therefore that the averages of the main features per sectional meeting and per joint meeting were as follows:

	Sectional meeting	Joint meeting
Attendance per meeting.......	34	205
Duration of meeting..........	86 minutes	96 minutes
Papers read per meeting........	4½	5½
Papers discussed per meeting ...	2	3
Participants in discussion per meeting..................	5	9
Minutes used for reading a paper	8½	10
Minutes used for discussing a paper.....................	12	11

About 48% of the papers presented in Sectional meetings were discussed and about 53% of the papers presented at joint-meetings; about two-thirds as much time was spent in discussing as in reading papers at sectional meetings and about three-fifths as much in discussing as in reading papers at joint meetings.

The Attendances

Taking the final total registration as a basis and assuming further that only members were present (which is manifestly not a thoroughly fair basis or assumption, but the best measure that can be conveniently applied) it appears that the attendance upon these 146 meetings, for each meeting period (of which there were 12 of 2 hours each) ranged from 5.4% at the last meeting period to 95.6 at the meeting of Saturday afternoon, September 7th, as shown in the following table:

Session of			Attendance	% of Total Registration
September	6	forenoon...........	558	29.6
		afternoon.........,.	742	39.4
September	7	forenoon...........	815	43.2
		afternoon..........	1800	95.6
September	9	forenoon...........	854	45.4
		afternoon..........	689	36.6

Session of			Attendance	% of Total Registration
September	10	forenoon	962	52.1
		afternoon	593	31.5
September	11	forenoon	1118	59.4
		afternoon	1024	54.4
September	12	forenoon	465	24.7
		afternoon	101	5.4

Grand average attendance 44.5 per cent.

THE MEETING PERIODS

As provided for in the program there was a total of 12 meeting periods containing a total of 530 meeting hours, or 265 meetings in all. The time actually consumed in meetings was 217 hours or 41% of the time provided and 146 separate meetings were held. This last figure must be augmented by the number of sections participating in joint sessions since each joint session is a meeting for each section i. e., 39 meetings more than 146 were held or the equivalent of 185 sectional meetings or 80 meetings i. e., 30% short of program capacity.

The following table shows the joint and sectional meetings reported by the Sectional Secretaries.

Section	Joint meetings	Sectional meetings	Total meetings	Section	Joint meetings	Sectional meetings	Total meetings
1	4	6	10	6a	4	8	12
2	6	5	11	6b	1	6	7
3a	6	5	11	7	2	8	10
3b	1	6	7	8a	1	4	5
3c	0	2	2	8b	1	9	10
4	3	8	11	8c	2	7	9
4a	3	1	4	8d	0	4	4
5a	1	7	8	9	1	6	7
5b	3	5	8	10a	8	2	10
5c	7	3	10	10b	5	3	8
5d	0	2	2	11a	1	3	4
5e	1	8	9	11b	6	0	6
			Totals		67	118	185

TABLE NO. 2.

Summary of each Meeting Period (see p. 475).

		Number of meetings held	Attendance	Duration in minutes	Number of papers		Resolutions offered	Papers carried over	Left-over papers read at subsequent meetings	Papers read by			Exhibits and specimens	Lantern	Experiments	Number of participants in discussions	Time in minutes used in	
					Read	Discussed				Author	Author's representative	Title					Reading	Discussing
Sept. 6 A. M....	sectional meetings..	21	558	1655	65	31	2	39	—	33	21	18	4	3	—	67	711	342
P. M.	sectional meetings..	13	542	1173	60	30	—	44	8	36	10	11	7	1	—	63	507	354
	joint meetings......	1	200	150	2	—	—	—	—	2	—	—	—	2	—	—	60	—
	total meetings......	14	742	1323	62	30	—	44	8	38	10	11	7	3	—	63	567	354
Sept. 7 A. M.	sectional meetings..	13	430	1209	46	29	1	33	6	22	12	7	4	1	—	79	532	436
	joint meetings......	3	385	285	16	14	—	14	—	8	7	1	1	—	—	57	131	189
	total meetings......	16	815	1494	62	43	1	47	6	30	19	8	5	1	—	136	663	625
P. M.	joint meeting.......	1	1800	60	1	—	—	—	—	1	—	—	—	1	—	—	60	—
Sept. 9 A. M.	sectional meetings..	17	652	1517	94	53	5	13	11	59	26	9	3	—	1	111	764	537
	joint meetings......	2	202	215	15	8	—	1	—	6	2	7	—	—	—	27	82	116
	total meetings......	19	854	1732	109	61	5	14	11	65	28	16	3	—	1	138	846	753
P. M.	sectional meetings..	10	376	741	41	16	—	5	1	22	11	8	—	—	1	44	295	185
	joint meetings......	3	313	270	16	8	—	1	1	7	2	7	1	1	1	8	130	45
	total meetings......	13	689	1011	57	24	—	6	2	29	13	15	1	1	2	52	425	230
Sept. 10 A. M.	sectional meetings..	13	539	1185	60	29	8	6	9	35	13	12	4	1	—	80	637	373
	joint meetings......	3	423	318	18	9	—	5	1	10	3	5	2	—	—	23	222	107
	total meetings......	16	962	1503	78	38	8	11	10	45	16	17	6	1	—	103	859	480
P. M.	sectional meetings..	8	274	659	36	12	6	4	7	17	5	14	6	—	2	38	196	198
	joint meetings......	2	319	230	11	9	—	1	—	11	—	—	3	4	1	21	120	88
	total meetings......	10	593	889	47	21	6	5	7	28	5	14	9	4	3	59	316	286
Sept. 11 A. M.	sectional meetings..	5	88	399	22	14	—	7	3	13	6	3	—	—	—	36	207	99
	joint meetings......	2	1030	185	7	4	—	—	—	5	—	2	—	1	—	15	102	80
	total meetings......	7	1118	584	29	18	—	7	3	18	6	5	—	1	—	51	309	179
P. M.	sectional meetings..	3	78	215	16	7	—	7	3	8	—	8	3	2	—	18	103	62
	joint meetings......	7	946	640	41	17	1	2	3	25	8	8	7	3	2	52	452	167
	total meetings......	10	1024	855	57	24	1	9	6	33	8	16	10	5	2	70	555	229
Sept. 12 A. M.	sectional meetings..	11	366	1116	79	27	—	—	28	33	14	32	7	—	—	63	530	289
	joint meetings......	3	99	290	18	10	—	1	—	15	1	2	1	—	—	33	169	110
	total meetings......	14	465	1406	97	37	—	1	28	48	15	34	8	—	—	96	699	399
P. M.	sectional meetings..	4	71	325	13	4	2	—	5	3	2	9	—	—	—	17	85	110
	joint meetings......	1	30	130	11	3	—	—	—	5	—	6	1	—	—	4	95	27
	total meetings......	5	101	455	24	7	2	—	5	8	2	15	1	—	—	21	180	137

TABLE NO. 3.

Summary of the Sectional Meetings (see p. 475).

	Number of meetings held	Attendance	Duration in minutes	Number of papers		Resolutions offered	Papers carried over	Left-over papers read at subsequent meetings	Papers read by			Exhibits and specimens	Lantern	Experiments	Number of participants in discussions	Time in minutes used in		Range of attendance		
				Read	Discussed				Author	Author's representative	Title					Reading	Discussing	Maximum	Minimum	Average
I. Analytical Chemistry........	6	240	480	29	10	4	9	1	23	1	5	2	—	—	21	180	75	50	27	40
II. Inorganic Chemistry.........	5	295	396	28	11	1	1	3	12	9	7	4	—	—	24	221	80	145	8	59
IIIa. Metallurgy and Mining......	5	210	385	24	10	4	15	3	11	2	11	5	4	—	18	194	97	62	10	42
IIIb. Explosives.................	6	254	480	23	6	1	6	7	14	4	5	—	—	—	15	285	95	50	38	42
IIIc. Silicate Industries...........	2	32	150	13	6	—	—	5	4	7	2	2	—	—	12	10	—	16	16	16
IV. Organic Chemistry...........	8	531	715	65	33	—	25	27	38	11	16	7	—	3	69	468	195	110	25	67
IVa. Coal Tar Dyes.............	1	29	125	5	3	—	—	—	4	1	—	—	—	—	9	68	45	29	29	29
Va. Sugar......................	7	147	496	31	10	—	3	2	17	6	8	3	—	—	18	237	87	31	12	21
Vb. India Rubber..............	5	143	182	11	5	—	3	4	6	—	5	2	—	—	18	79	55	78	11	29
Vc. Fuels and Asphalt...........	3	80	260	10	4	—	7	1	6	—	4	1	—	—	12	75	115	35	15	27
Vd. Fats, Fatty Oils and Soaps....	2	25	130	5	3	—	1	—	4	1	—	—	—	—	12	72	53	24	1(?)	13
Ve. Paints, Oils and Varnishes.....	8	367	657	18	15	—	5	3	15	3	—	2	1	—	71	312	202	69	23	46
VIa. Starch, Cellulose and Paper....	8	198	530	29	17	1	2	1	13	2	14	1	—	—	48	155	308	36	15	25
VIb. Fermentation...............	6	131	885	35	15	1	—	—	11	22	2	1	—	—	30	612	205	38	12	22
VII. Agricultural Chemistry.......	8	259	770	62	24	—	20	7	25	20	17	5	—	—	62	238	181	46	19	32
VIIIa. Hygiene..................	4	104	503	19	14	3	7	6	16	3	—	—	—	—	29	225	148	44	7	26
VIIIb. Pharmaceutical Chemistry....	9	265	855	18	13	5	1	3	3	15	—	—	—	—	25	290	450	50	20	29
VIIIc. Bromatology..............	7	152	550	45	5	3	2	5	10	6	29	—	—	—	11	113	50	29	14	22
VIIId. Biochemistry.............	4	96	210	12	n. r.*	—	—	—	11	—	1	—	—	—	n. r.*	n. r.*	n. r.*	40	6	24
IX. Photochemistry............	6	122	705	33	30	—	—	—	20	12	1	—	3	—	59	336	304	36	10	20
Xa. Physical Chemistry..........	2	147	113	9	4	—	6	—	6	1	2	3	—	—	7	94	19	112	35	74
Xb. Electrochemistry...........	3	85	250	13	7	—	22	3	13	—	—	—	—	—	20	201	83	50	20	28
XIa. Law and Legislation.........	3	44	300	9	7	1	12	—	4	3	2	—	—	—	20	132	140	20	12	15
XIb. Pol. Econ. and Conservation..	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals..........................	118	3956	10127	546	252	24	147	81	286	129	131	38	8	3	610	4,597	2,987	145	6	34

* n. r. no record by Sectional Secretary under this heading.

TABLE NO. 4.

Summary of the Joint Meetings (see p. 475).

Sections and Societies	Meeting Period	Attendance	Duration in minutes	Number of papers		Resolutions offered	Papers carried over	Left-over papers read at subsequent meetings	Papers read by			Exhibits and specimens	Lantern	Experiments	Number of participants in discussions	Minutes used in	
				Read	Discussed				Author	Author's representative	Title					Reading	Discussing
4a, 5e, 9	6P	200	150	2	—	—	—	—	2	—	—	—	2	—	—	60	—
3a, 10a, 11b, A. I. M. E.	7A	200	95	6	6	—	2	—	4	2	—	—	—	—	23	46	47
3b, 11a	7A	40	70	3	2	—	12	—	3	—	—	—	—	—	9	65	60
2 and 3a	7A	145	120	7	6	—	—	—	1	5	1	1	—	—	25	20	82
2, 7, 10b, 10a	7P	1800	60	1	—	—	—	—	1	—	—	—	1	—	—	60	—
2, 10a, 10b, A. E. C. S.	9A	150	120	8	6	—	1	—	5	1	2	—	—	—	18	59	51
5c and 11b	9A	52	95	7	2	—	—	—	1	1	5	—	—	—	9	23	65
8a and 8c	9P	58	105	6	2	—	1	—	4	—	2	—	—	—	5	45	25
4a and 6a	9P	55	45	6	2	—	—	—	2	2	2	—	—	—	3	35	20
2, 3a, 10a, 10b, A. E. C. S.	9P	200	120	4	2	—	—	1	1	—	3	1	1	1	—	50	—
6a, 10a, A. E. C. S.	10A	250	105	7	3	—	—	—	4	—	3	—	—	—	8	78	27
1 and 5c	10A	75	110	7	3	—	—	—	2	3	2	—	—	—	9	80	50
4 and 4a	10A	98	103	4	3	—	5	1	4	—	—	2	—	—	6	64	30
10a, 11b	10P	250	120	3	3	—	—	—	3	—	—	1	1	1	8	55	41
1 and 5c	10P	69	110	8	6	—	1	—	8	—	—	2	3	—	13	65	37
2, 7, 10a, 10b	11A	1000	60	1	—	—	—	—	1	—	—	1	1	—	—	60	—
3a and 5c	11A	30	125	7	4	—	—	—	5	—	2	—	1	—	15	42	80
2, 3a, 10b	11P	50	120	6	3	—	—	—	6	—	—	3	2	2	5	88	15
5a, 10a	11P	65	120	6	4	1	—	—	4	2	—	—	—	—	20	38	65
6a and 6b	11P	23	70	8	1	—	—	—	3	3	2	2	—	—	1	62	3
5c and 11b	11P	40	145	12	3	—	—	—	4	2	6	1	1	—	7	90	47
4 and 5b	11P	298	50	1	0	—	—	—	1	—	—	—	—	—	—	50	—
4 and 5b	11P	420	60	5	3	—	2	3	4	1	—	—	—	—	10	87	13
1, 8b, 8c	11P	50	75	3	3	—	—	—	3	—	—	1	—	—	9	37	24
5c, 11b	12A	35	140	9	4	—	—	—	7	—	2	—	—	—	6	110	30
5b, 6a	12A	14	35	4	1	—	—	—	4	—	—	—	—	—	4	6	25
1 and 3a	12A	50	115	5	5	—	1	—	4	1	—	1	—	—	23	53	55
5c, 11b	12P	30	130	11	3	—	—	—	5	—	6	1	—	—	4	95	27
Totals	28	5747	2873	157	80	1	25	5	96	23	38	17	13	4	250	1603	929

TABLE NO. 5.

PAPERS PRINTED BEFORE THE CONGRESS OPENED.

Sec.	Pages of text	Papers		Languages used			
		Total	Illus-trated	English	French	German	Italian
1	460	48	12	35	13	0	0
2	246	30	9	17	9	4	0
3a	150	13	5	12	0	0	1
3b	150	19	4	15	2	2	0
3c	131	14	5	14	0	0	0
4	264	36	3	31	1	4	0
4a	24	3	0	1	2	0	0
5a	104	15	1	9	3	3	0
5b	92	8	3	4	3	1	0
5c	334	33	12	27	3	3	0
5d	36	6	1	5	0	1	0
5e	212	19	5	16	2	1	0
6a	294	34	12	31	2	1	0
6b	278	28	4	21	5	2	0
7	371	53	5	39	12	2	0
8a	50	5	0	3	2	0	0
8b	95	14	0	14	0	0	0
8c	358	39	3	30	7	1	1
8d	282	39	4	19	16	2	2
9	280	33	6	33	0	0	0
10a	209	21	11	20	0	1	0
10b	252	27	11	21	3	3	0
11a	79	13	0	2	11	0	0
11b	193	10	2	10	0	0	0
Totals	4944	560	118	429	96	31	4

TABLE NO. 6

PAPERS PRINTED AFTER THE CONGRESS CLOSED

Sec.	Pages of text	Papers		Language used			
		Total	Illus-trated	English	French	German	Italian
1	104	7	2	6	0	1	0
2	81	10	2	7	1	2	0
3a	23	6	1	4	2	0	0
3b	107	7	2	6	1	0	0
3c	12	2	0	1	1	0	0
4	136	31	2	21	6	4	0
4a	16	4	0	4	0	0	0
5a	84	15	0	4	11	0	0
5b	60	5	2	5	0	0	0
5c	154	28	2	21	1	6	0
5d	6	1	0	0	0	1	0
5e	21	3	0	3	0	0	0
6a	32	6	0	2	0	4	0
6b	54	11	1	9	0	2	0
7	80	10	0	9	1	0	0
8a	152	13	4	13	0	0	0
8b.....	34	5	0	4	0	1	0
8c	60	12	2	10	0	1	1
8d	8	2	0	0	2	0	0
9	32	5	1	4	1	0	0
10a	112	11	5	11	0	0	0
10b	84	14	2	12	0	2	0
11a	46	7	0	1	0	6	0
11b	130	14	1	14	0	0	0
Totals	1,628	229	29	171	27	30	1

TABLE NO. 7

Table Showing Totals of Details of all Papers Printed.

Sec.	Pages of text	Papers		Language used			
		Total	Illustrated	English	French	German	Italian
1	564	55	14	41	13	1	0
2	327	40	11	24	10	6	0
3a	173	19	6	16	2	0	1
3b	257	26	6	21	3	2	0
3c	143	16	5	15	1	0	0
4	400	67	5	52	7	8	0
4a	40	7	0	5	2	0	0
5a	188	30	1	13	14	3	0
5b	152	13	5	9	3	1	0
5c	488	61	14	48	4	9	0
5d	42	7	1	5	0	2	0
5e	233	22	5	19	2	1	0
6a	326	40	12	33	2	5	0
6b	332	39	5	30	5	4	0
7	451	63	5	48	13	2	0
8a	202	18	4	16	2	0	0
8b	129	19	0	18	0	1	0
8c	418	51	5	40	7	2	2
8d	290	41	4	19	18	2	2
9	312	38	7	37	1	0	0
10a	321	32	16	31	0	1	0
10b	336	41	13	33	3	5	0
11a	125	20	0	3	11	6	0
11b	323	24	3	24	0	0	0
Totals	6,572	789	147	600	123	61	5
Per cent.	——	100	18.63	76.04	15.59	7.73	0.64

DISCUSSIONS

Table No. 1 page 473 shows that a grand total of 332 papers were discussed by a grand total of 860 participants. However, the discussions printed in volume 27 show that only 172 were discussed and by only 439 participants (i. e. 247 different individuals or 13.1% of the registered attendance) and reported for publication. It appears therefore that the discussion of 160 papers or 48% and of 421 participants or 49% failed of finding a place in the final printed volume. The reasons therefor are probably correctly stated at page 2 of Vol. 27. The following table shows the detail of the recorded discussions.

Distribution of papers, discussions of which were printed in volume 27:

TABLE NO. 8.

Sec.	Vol. 1–24	Appendix	Total	No. of participants reported
1.......	17	3	20	56
2.......	8	1	9	21
3a......	1	1	2	4
3b......	8	1	9	14
3c......	1	0	1	2
4.......	6	6	12	25
4a......	1	2	3	7
5a......	5	5	10	23
5b......	2	1	3	8
5c......	10	5	15	45
5d......	2	1	3	7
5e......	15	2	17	62
6a......	8	0	8	13
6b......	1	0	1	2
7.......	21	6	27	70
8a......	0	1	1	1
8b......	3	0	3	4
8c......	7	1	8	16
8d......	1	0	1	1
9.......	0	0	0	0
10a......	11	7	18	56
10b......	0	0	0	0
11a......	1	0	1	2
11b......	0	0	0	0
Totals	129	43	172	439

PARTICIPATION IN THE SECTIONS

From page 478 it appears that papers in the English language were offered in each of the 24 sections; that papers in the French language were offered in 20 of the 24 sections, in the German language in 18 of the 24 sections, and in the Italian language in 3 of the 24 sections. It further appears that in the sections on Fats, Fatty Oils and Soaps, Pharmaceutical Chemistry, Physical Chemistry and on Politcal Economy and Conservation of Natural Resources writers in the French language made no original communications; that in the Sections on Metallurgy and Mining, Silicate Industries, Coal-tar Colors and Dyestuffs, Hygiene, Photochemistry and on Political Economy and Conservation of Natural Resources writers in the German language made no original communications and that writers in the Italian language made original communications only in Metallurgy and Mining, in Bromatology and in Biochemistry.

REPORTS TO THE CONGRESS

Of the eighteen reports from Committees or Commissions that should have been made to the Eighth Congress only two were received and these were ordered printed, which has been done.

MEMBERSHIP AND REGISTRATION

The total membership in the Congress was 4,163 members from 36 different countries and 277 lady members from 12 different countries. The grand total membership being 4440 from 36 different countries.

The attendance was 1883 members from 27 different countries and 246 ladies from 12 different countries, the grand total attendance being 2129 from 27 countries.

The following table gives the details:

TABLE NO. 9.

Country	Members		Ladies		Grand Totals	
	Total	Regist'd.	Total	Regist'd.	Total	Regist'd.
Africa	9	1			9	1
Argentina	81	0			81	0
Australia	6	4	1	1	7	5
Austria	113	27	8	8	121	35
Belgium	16	5	2	2	18	7
Brazil	4	2			4	2
Bulgaria	1	1			1	1
Canada	83	38	6	6	89	44
Chile	21	2	1	1	22	3
China	2	2			2	2
Cuba	6	1	1	1	7	2
Denmark	5	5			5	5
Dutch E. Indies	1	0			1	0
France	185	21	5	4	190	25
Germany	219	177	31	22	250	199
Great Britain and Ireland	99	46	13	13	112	59
Greece	23	0			23	0
Hungary	24	8			24	8
India	4	0			4	0
Italy	43	9			43	9
Japan	21	13			21	13
Malay States	1	0			1	0
Mexico	6	2			6	2
New Zealand	2	1			2	1
Netherlands	16	7			16	7
Norway	26	4	1	1	27	5
Paraguay	1	0			1	0
Peru	1	0			1	0
Portugal	15	3	1	1	16	4
Russia	56	27			56	27
Spain	23	1			23	1
Sweden	6	2			6	2
Switzerland	4	1			4	1
Turkey	1	1			1	1
West Indies	2	0			2	0
United States	3,037	1,472	207	186	3,244	1,658
Totals	4,163	1,883	277	246	4,440	2,129

FACTORY INSPECTION AND WORKS VISITS

Members of the Congress in parties of larger or smaller number and all of them in charge of the Committee on Excursions visited and inspected 146 different private chemical manufacturing plants in 24 different cities; this, in addition to a large number of private manufacturing plants of general interest as well as many public, municipal, State and Federal institutions operating along chemical lines; they further visited many public institutions and undertakings in those 24 cities and in 13 other cities, where they were officially received and entertained.

In addition to these official parties many members visited such private chemical plants both before and after the Congress, but of these visits no record is here made.

This report cannot be closed without bringing to the notice of the Congress the thorough, complete and most loyal coöperation of the Rumford Press in executing the difficult and trying work of printing the Report of this Congress under exacting and harassing conditions, of Mr. Thomas A. Edison and his entire staff in originating a suitable device for recording discussions, and of Miss C. E. Davidson in organizing a corps of transcribers and stenographers to reproduce these recorded discussions in typewriting. The assistance derived from all of these was of the utmost value to the Congress and far beyond any monetary consideration involved. Any shortcomings in the work of these are not due to any faults or omissions of theirs or of their aids, but are due substantially entirely to the failure of members of this Congress to do their share properly and promptly.

Respectfully submitted,

BERNHARD C. HESSE,
Secretary.

New York, March 31, 1913.

Date Due

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